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ABSTRACT

The Rate Training Manual and Nonresident Career Course (RTM/NRCC) form a self-study package that will enable Aviation Boatswain's Mates F (Fuels) to help themselves fulfill the requirements of their rating. Designed for individual study and not formal classroom instruction, the RTM provides subject matter that relates directly to the occupational qualifications fo the Aviation Boatswain's Mate F (ABF) rating. Subjects presented involve operation, maintenance, and repair of aviation fueling and lubricating oil systems on aircraft carriers and other ships having aircraft aboard. Appended is a section of information on the metric systems and a glossary. Qualifications for advancement are listed followed by the NRCC, which consists of a set of assignments that includes learning objectives and supporting items (questions) designed to lead students through the RTM (which serves as a textbook). By answering the supporting items in the self-scoring test booklet (not included in the document), and following the other described instructions, the student can satisfy the requirements for completing the RTM, (Author/MS)

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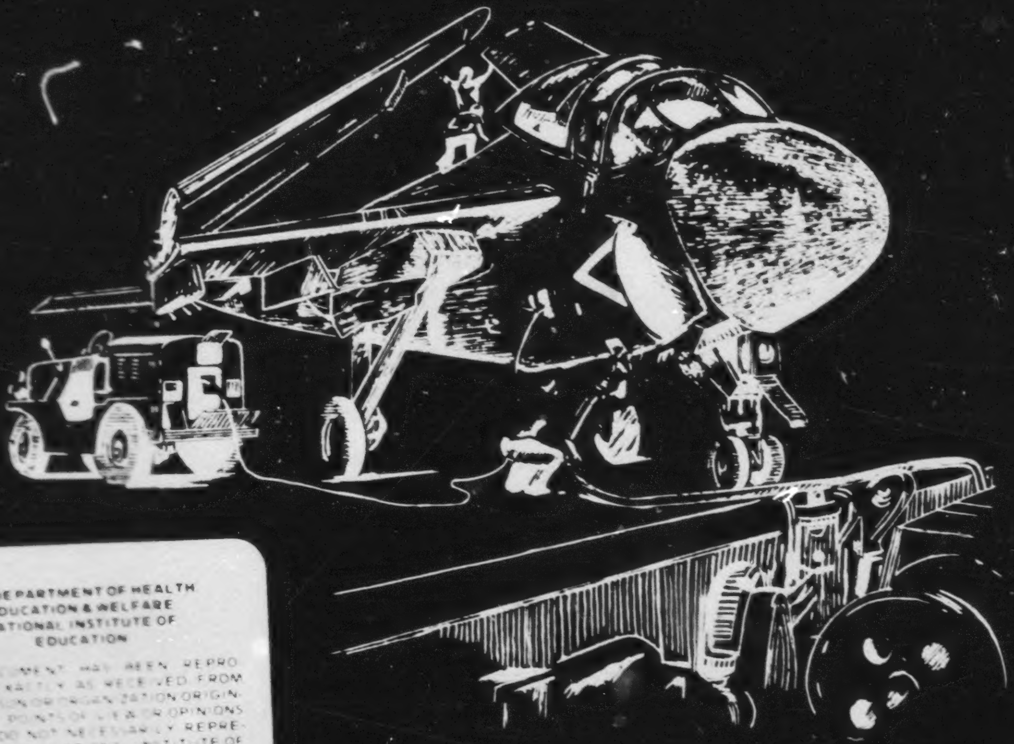

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AVIATION
BOATSWAIN'S MATE F 3 & 2

NAVAL EDUCATION AND TRAINING COMMAND

RATE TRAINING MANUAL
AND NONRESIDENT CAREER COURSE
NAVEDTRA 10301-D

CE 006 722

PREFACE

The ultimate purpose of training Naval personnel is to produce a combatant Navy which can ensure victory at sea. A consequence of the quality of training given them is their superior state of readiness. Its result is a victorious Navy.

This Rate Training Manual and Nonresident Career Course (RTM/NRCC) form a self-study package that will enable ambitious Aviation Boatswain's Mates F to help themselves fulfill the requirements of their rating.

Designed for individual study and not formal classroom instruction, the RTM provides subject matter that relates directly to the occupational qualifications of the Aviation Boatswain's Mate F rating. The NRCC provides the usual way of satisfying the requirements for completing the RTM. The set of assignments in the NRCC includes learning objectives and supporting items designed to lead students through the RTM.

This Rate Training Manual and Nonresident Career Course were prepared by the Naval Education and Training Program Development Center, Pensacola, Florida, for the Chief of Naval Education and Training. Technical assistance was provided by the Aviation Boatswain's Mate School, Lakehurst, New Jersey and the Naval Sea Systems Command.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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Chapter 1

AVIATION BOATSWAIN'S MATE F RATING

This Rate Training Manual is designed as a self-study text for use by those personnel of the Navy and Naval Reserve who are preparing to meet the professional (technical) qualifications for advancement to Petty Officer Third Class and Petty Officer Second Class in the Aviation Boatswain's Mate F (ABF) rating. A second purpose of this manual is the improvement of job skills. This purpose is achieved through use of the manual as a study aid in conjunction with on-the-job training.

Minimum professional qualifications for advancement in all ratings are listed in the Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards, NAVPERS 18068 (Series). Formerly designated as the Manual of Qualifications for Advancement, NAVPERS 18068 is often referred to as the "Quals" Manual.

The occupational standards upon which this Rate Training Manual is based are those appearing in Change C of NAVPERS 18068. It should be kept in mind that any changes in the qualifications occurring after the (C) revision of the "Quals" Manual may not be reflected in the information presented in this training manual.

This chapter provides information on the enlisted rating structure, the ABF rating, requirements and procedures for advancement, and references that will help you in working for advancement and in performing your duties as an ABF. Also included is information on how to make the best use of Rate Training Manuals. It is therefore strongly recommended that you study this chapter carefully before beginning intensive study of the remainder of the manual.

ENLISTED RATING STRUCTURE

The present enlisted rating structure consists of general ratings and service ratings.

General ratings identify broad occupational fields of related duties and functions. Some general ratings include service ratings; others do not. Both Regular Navy and Naval Reserve personnel may hold general ratings.

The general rating provides the primary means of identifying billet requirements and personnel qualifications; it is established or disestablished by the Secretary of the Navy; and it is provided a distinctive rating badge. The general rate is the pay grade level within the general rating.

Service ratings identify subdivisions or specialities within a general rating which require related patterns of aptitudes and qualifications, and which provide paths of advancement for career development. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both Regular Navy and Naval Reserve personnel may hold service ratings.

The Navy Enlisted Classification Coding System (NEC) has been set up to help the Navy match the right person with the right job. By identifying billets that require special skills, and by identifying people who have or can develop these special skills, the NEC system provides the Navy with a means of getting maximum usefulness from its manpower. Any person who gains the qualifications associated with one of the special skills is given a code number, called his NEC.

AVIATION BOATSWAIN'S MATE RATING

The Aviation Boatswain's Mate rating is divided into three service ratings in pay grades E-4 through E-7. The service ratings are Aviation Boatswain's Mate H (Aircraft Handling), Aviation Boatswain's Mate E (Launching and Recovery Equipment), and Aviation Boatswain's Mate F (Fuels). The general rating, AB, applies at the E-8 and E-9 levels.

Figure 1-1 illustrates all paths of advancement for an Airman Recruit to Master Chief Aviation Boatswain's Mate. Notice that each enlisted pay grade has a name; for example, E-1, Recruit. An E-4 is called Aviation Boatswain's Mate F 3rd class; an E-9 is called Master Chief Aviation Boatswain's Mate.

Figure 1-2(A) illustrates the active duty advancement requirements from E-1 through E-9. Figure 1-2(B) illustrates the inactive duty advancement requirements.

Personnel in the ABF rating operate, maintain, and repair aviation fueling and lubricating oil systems on aircraft carriers and other ships having aircraft aboard. This includes fuel and lubricating oil service stations and pumprooms, piping, valves, pumps, tanks, and portable equipment related to fuel systems. ABFs also operate, maintain, and repair the valves and piping of purging and protective systems within the air department spaces aboard carriers. ABFs supervise the operation and servicing of fuel pits, fuel farms, and equipment associated with the fueling and defueling of aircraft ashore and afloat. ABFs also operate and service motorized fueling equipment, maintain fuel quality surveillance and control in aviation fuel systems ashore and afloat; train, direct, and supervise firefighting crews, fire rescue teams, and damage control parties in assigned fuel and lubricating oil spaces; and observe and enforce fuel-handling safety precautions.

A brief survey of billet types in which ABFs serve is provided here to give you an overall view of the various duties which ABFs perform. As you read through these billet discussions, note the close correlation between the military requirements for petty officers and the specialty or professional requirements for ABFs. It will be seen that the military and specialty requirements are inseparable. They supplement one another. Both make for a better qualified and a more professional military person.

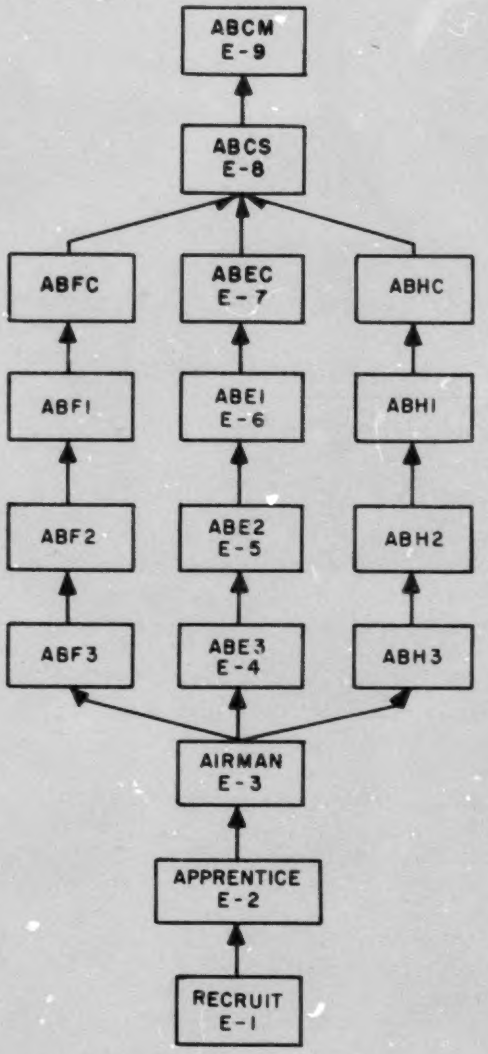

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Figure 1-1.—Enlisted paths of advancement.

It will also be noted in this survey that the ABF performs more and more of his duties with less and less supervision as he advances to the higher rates. After considering the additional privileges enjoyed by petty officers, particularly by the higher rated petty officers, and the

REQUIREMENTS *	E1 to E2	E2 to E3	# E3 to E4	# E4 to E5	E5 to E6	† E6 to E7	† E7 to E8	† E8 to E9
SERVICE	4 mos. service—or completion of Recruit Training.	8 mos. as E-2.	6 mos. as E-3. 2 years time in service.	12 mos. as E-4. 3 years time in service.	24 mos. as E-5. 6 years time in service.	36 mos. as E-6. 8 years time in service.	36 mos. as E-7. 8 of 11 years time in service must be enlisted.	24 mos. as E-8. 10 of 13 years time in service must be enlisted.
SCHOOL	Recruit Training. (C.O. may advance up to 10% of graduating class.)	▨	Class A for PR3, DT3, PT3, AME 3, HM 3, PN 3, FTB 3, MT 3,	▨	▨	Navy School MUC, MNC.††		
PRACTICAL FACTORS	Locally prepared check-offs.	Record of Practical Factors, NavEdTra 1414/1, must be completed for E-3 and all PO advancements.						
PERFORMANCE TEST	▨	▨	Specified ratings must complete applicable performance tests before taking examinations.				▨	▨
ENLISTED PERFORMANCE EVALUATION	As used by CO when approving advancement.		Counts toward performance factor credit in advancement multiple.					
EXAMINATIONS **	Locally prepared tests.	See below.	Navy-wide examinations required for all PO advancements.			Navy-wide selection board.		
RATE TRAINING MANUAL (INCLUDING MILITARY REQUIREMENTS)	▨	Required for E-3 and all PO advancements unless waived because of school completion, but need not be repeated if identical course has already been completed. See NavEdTra 10052 (current edition).					Nonresident career courses and recommended reading. See NavEdTra 10052 (current edition).	
AUTHORIZATION	Commanding Officer		NAVEDTRA PRODEVCEN					

* All advancements require commanding officer's recommendation.
† 2 years obligated service required for E-7, E-8, and E-9.
# Military leadership exam required for E-4 and E-5.
** For E-2 to E-3, NAVEDTRA PRODEVCEN exams or locally prepared tests may be used.
†† Waived for qualified EOD personnel.

Figure 1-2(A).—Active duty advancement requirements.

REQUIREMENTS *	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7	E8	E9
TOTAL TIME IN GRADE	4 mos.	8 mos.	6 mos.	12 mos.	24 mos.	36 mos. with total 8 yrs service	36 mos. with total 11 yrs service	24 mos. with total 13 yrs service
TOTAL TRAINING DUTY IN GRADE†	14 days	14 days	14 days	14 days	28 days	42 days	42 days	28 days
PERFORMANCE TESTS	▨		Specified ratings must complete applicable performance tests before taking examination.					
DRILL PARTICIPATION	Satisfactory participation as a member of a drill unit in accordance with BUPERSINST 5400.42 series.							
PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS)	Record of Practical Factors, NavEdTra 1414/1, must be completed for all advancements.							
RATE TRAINING MANUAL (INCLUDING MILITARY REQUIREMENTS)	Completion of applicable course or courses must be entered in service record.							
EXAMINATION	Standard Exam		Standard Exam required for all PO advancements. Also pass Military Leadership Exam for E-4 and E-5.				Standard Exam, Selection Board.	
AUTHORIZATION	Commanding Officer		NAVEDTRA PRODEVCEN					

* Recommendation by commanding officer required for all advancements.
† Active duty periods may be substituted for training duty.

Figure 1-2(B).—Inactive duty advancement requirements.

personal satisfaction that goes with assuming greater responsibility and the discharging of this responsibility, it should behoove you to work for advancement in both your specialty and military requirements.

The aviation fuels chief supervises the personnel assigned to the aviation fuels division. An ABF1 is normally in charge of the flight deck fueling crews. The hangar deck fueling crews are similarly supervised. Third and second class ABFs are assigned to the pumprooms, as petty officers in charge of particular fueling crews, and as members or petty officers in charge of the aviation fuels system repair crews. Airmen who are striking for ABF are assigned to each of these crews. They service aircraft and perform maintenance on the aviation fuels system under the supervision of the petty officers.

A third or second class petty officer is in charge of the lube oil system. He is assigned a number of Airmen to help him operate and maintain the lube oil system, thus providing lube oil at the ready service outlets for the squadron plane captains.

ABFs operate and maintain the aviation fuels and lube oil systems, service aircraft, operate aircraft cranes, operate aircraft refueling boats, and perform other aviation seamanship duties.

The operation of mobile refuelers at most naval air stations is done by civilian personnel. However, the ABF may be assigned for assistance in the actual refueling of aircraft. This type of billet comes under the station supply department.

Since you have been in pay grade E-3 or E-4 for some time, you realize that more leadership is required of the higher rates. Not only are you required to have superior knowledge, but you are also required to have the ability to handle personnel. This ability increases in importance as you advance through the various rates as a petty officer.

In General Order No. 21, the Secretary of the Navy outlined some of the most important aspects of naval leadership. By naval leadership is meant the art of accomplishing the Navy's mission through people. It is the sum of those qualities of intellect, of human understanding, and of moral character that enables a person to inspire and to manage a group of people successfully. Effective leadership, therefore, is based on personal example, good management practices, and moral responsibility. The term leadership includes all three of these elements.

The current Navy Leadership Program is designed to keep the spirit of General Order No. 21 ever before you. If the threefold objective is carried out effectively in every command, the program will make you a better leader of men in your present billet and in your future assignments. As you advance up the ladder of leadership, your worth to the Navy will be judged increasingly on the basis of the amount of efficient work you obtain from your subordinates rather than how much of the actual work you do yourself.

For information on the practical application of leadership and supervision, study *Military Requirements for Petty Officer 3 & 2*, NAVEDTRA 10056 (Series).

ADVANCEMENT

Both you and the Navy benefit from your advancement. You get more pay, and your assignments are more interesting and challenging. You can enjoy getting ahead in the Navy on your own efforts. Highly trained personnel are essential to the functioning of the Navy. By advancement, you increase your value to the Navy in two ways: First, you become more valuable as a technical specialist in your own rating; and second, you become more valuable as a person who can train others, and thus make far-reaching contributions to the entire Navy.

The advancement system includes those requirements that must be met before you may be considered for advancement and those factors that actually determine whether or not you will be advanced. In this part of this chapter information is presented to help you prepare and become qualified for advancement and to inform you of the method used for selecting those who will be advanced.

BUPERS Notice 1418 will give you information on advancement examinations. Have your Educational Services Officer or your

Training Petty Officer explain parts of these notices you do not understand.

PREPARING FOR ADVANCEMENT

What must you do to prepare for advancement? You must study the qualifications for advancement, work on the practical factors, study the required Rate Training Manuals and other material that is required. You will need to be familiar with the following:

1. Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards, NAVPERS 18068 (Series).
2. Record of Practical Factors, NAVEDTRA 1414/1.
3. Bibliography for Advancement Study, NAVEDTRA 10052 (Series).
4. Applicable Rate Training Manuals and their companion Nonresident Career Courses.
5. Examination for advancement procedures.

Collectively, these documents make up an integrated training package tied together by the occupational standards. The following paragraphs describe these materials and give some information on how each one is related to the others.

"Quals" Manual

The Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards, NAVPERS 18068 (Series), gives the minimum requirements for advancement. This manual is usually called the "Quals" Manual, and the qualifications themselves are called occupational standards. The "Quals" Manual can be found in your Educational Services Office or may be obtained from your Training Petty Officer.

Occupational standards are expressed as task statements only, unlike the advancement qualifications which contain practical factors and knowledge factors. The approved concept for occupational standards is that they define what enlisted personnel must do in their rate or rating and that the knowledges required to perform a task are inherent to the proper performance of the task. The practical and knowledge factors presently in the "Quals" Manual will be replaced with occupational standards.

Occupational standards are identified by a five-digit number of which the first two digits identify the standard topic title and the remaining three digits identify the specific task statement.

NOTE: As stated previously, the occupational standards upon which this Rate Training Manual is based are those appearing in NAVPERS 18068-C, which is titled Manual of Qualifications for Advancement. Therefore, the material is based on practical and knowledge factors which are identified by alphanumeric codes. For example, G2.03, "Use of publications relating to the inspection, servicing, and maintenance of aircraft," is a knowledge factor under this system. In the new NAVPERS 18068 (Series), Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards, the above occupational standard will probably appear as 46091, "Use publications and instructions to perform inspections, servicing, and maintenance of aircraft." Any reference to qualifications or occupational standards in this manual pertains to the old system.

The standards are of two general types: military requirements, and professional (or technical) requirements.

Military requirements apply to all ratings rather than to any one particular rating. Military requirements for advancement to third class and second class petty officer rates deal with military conduct, naval organization, military justice, security, watch standing, and other subjects which are required of petty officers in all other ratings.

Professional requirements are technical or professional in nature and are directly related to the work of each rating. Both the military requirements and the professional requirements are divided into subject matter groups; then within each subject matter group, they are divided into specific task statements.

The occupational standards for ABF are listed in this manual following the index. Study these standards and the military requirements carefully. The majority of the questions on your advancement examination will try to determine your understanding of the requirements reflected in the occupational standards. If you are working for advancement to second class, remember that you may be examined on third class occupational standards as well as on second class occupational standards.

It is essential that the occupational standards reflect current requirements of fleet and shore operations, and that new fleetwide technical, operational, and procedural developments be included. For these reasons, the occupational standards are continually under evaluation. Although there is an established schedule for revisions to the occupational standards for each rating, urgent changes to the occupational standards may be made at any time. These revisions are issued in the form of changes to the "Quals" Manual. Therefore, never trust any set of occupational standards until you have checked the change number against an up-to-date copy of the "Quals" Manual. Be sure you have the latest revision.

Record of Practical Factors, NAVEDTRA 1414/1

Before you can take the Navy-wide examination for advancement, there must be an entry in your service record to show that you have qualified in the practical factors of both the military requirements and the professional standards. A special form known as the Record of Practical Factors, NAVEDTRA 1414/1 (plus the abbreviation of the appropriate rating), is used to keep a record of your practical factor qualifications. The form lists all practical factors, both military and professional. As you demonstrate your ability to perform each practical factor, appropriate entries are made in the DATE and INITIALS columns.

Changes are made periodically to the "Quals" Manual, and revised forms of NAVEDTRA 1414/1 are provided when necessary. Extra space is allowed on the Record of Practical Factors for entering additional practical factors as they are published in changes. The Record of Practical Factors also provides space for recording demonstrated proficiency in skills which are within the general scope of the rate but which are not identified as minimum qualifications for advancement.

If you are transferred before you qualify in all practical factors, NAVEDTRA 1414/1 should be forwarded with your service record to your next duty station. You can save yourself a lot of trouble by making sure that this form is actually inserted in your service record before you are transferred. If the form is not in your service record, you will be required to start over again and requalify in the practical factors which have already been checked off.

A second copy of the Record of Practical Factors should be made available to each man in pay grades E-2 through E-8 for his personal record and guidance.

The importance of NAVEDTRA 1414/1 must be strongly emphasized. It serves as a record to indicate to the petty officers and officers supervising your work that you have demonstrated proficiency in the performance of the indicated practical factors and is part of the criteria utilized by your commanding officer when he considers recommending you for advancement. In addition, the proficient demonstration of the applicable practical factors listed on this form can aid you in preparing for the examination for advancement. Remember that the knowledge aspects of the practical factors are covered in the examinations for advancement. Certain knowledge is required to demonstrate these practical factors and additional knowledge can be acquired during the demonstration. Background knowledge is required to perform a certain job. In other words, the knowledge required for a certain rating depends upon the jobs (practical factors) that must be performed by personnel of that rating. Therefore, the knowledge required to proficiently demonstrate these practical factors will definitely aid you in preparing for the examination for advancement.

Personnel Qualification Standards

Personnel Qualification Standards (PQS), described in OPNAV Instruction 3500.34, are presently being utilized to provide guidelines in preparing for advancement and qualification to operate specific equipment and systems. They are designed to support the advancement requirements as stated in the "Quals" Manual.

The occupational standards and Record of Practical Factors are stated in broad terms. Each PQS is much more specific in its questions that lead to qualification. It provides an analysis of specific equipment and duties, assignments, or responsibilities which an individual or group of individuals (within the same rating) may be called upon to carry out. In other words, each PQS provides an analysis of the complete knowledge and skills required of that rating tied to a specific weapon system (aircraft and/or individual systems or components).

Each qualification standard has four main subdivisions in addition to an introduction and a glossary of PQS terms. They are as follows:

100 Series–Theory
200 Series–System
300 Series–Watchstations (duties, assignments or responsibilities)
400 Series–Qualification cards

The introduction explains the complete use of the qualification standard in terms of what it will mean to the user as well as how to use it.

The Theory (100 Series) section specifies the theory background required as a prerequisite to the commencement of study in the specific equipment or system for which the PQS was written. These fundamentals are normally taught in the formal schools (Preparatory, Fundamentals, and Class A) phase of an individual's training. However, if the individual has not been to shcool, the requirements are outlined and referenced to provide guidelines for a self-study program.

The Systems (200 Series) section breaks down the equipment or systems being studied into functional sections. PQS items are essentially questions asked in clear, concise statement (question) form and arranged in a standard format. The answers to the questions must be extracted from the various maintenance manuals covering the equipment or systems for which the PQS was written. This section asks the user to explain the function of the system, to draw a simplified version of the system from memory, and to use this drawn schematic or the schematic provided in the maintenance manual while studying the system or equipment. Emphasis is given to such areas as maintenance management procedures, components, component parts, principles of operation, system interrelations, numerical values considered necessary to operation and maintenance, and safety precautions.

The Watchstation (300 Series) section includes questions regarding the procedures the individual must know to operate and maintain the equipment or system. A study of the items in the 200 series section provides the individual with the required information concerning what the system or equipment does, how it does it, and other pertinent aspects of operation. In the 300 series section, the questions advance the qualification process by requiring answers or demonstrations of ability to put this knowledge to use or to cope with maintenance of the system or equipment. Areas covered include normal operation; abnormal or emergency operation; emergency procedures which could limit damage and/or casualties associated with a particular operation; operations that occur too infrequently to be considered mandatory performance items; and maintenance procedures/instructions such as checks, tests, repair, replacement, etc.

The 400 Series section consists of the qualification cards. These cards are the accounting documents utilized to record the individual's satisfactory completion of items necessary for becoming qualified in duties assigned. Where the individual starts in completing a standard will depend on his assignment within an activity. The complete PQS should be given to the individual being qualified so that he can utilize it at every opportunity to become fully qualified in all areas of his rating and the equipment or system for which the PQS was written. Upon transfer to a different activity, each individual must requalify. The answers to the questions asked in the qualification standards may be given orally or in writing to the supervisor, the branch or division officer, and maintenance officer as required to certify proper qualification. The completion of part or all of the PQS provides a basis for the supervising petty officer and officer to certify completion of Practical Factors for Advancement.

Bibliography for Advancement Study

The Bibliography for Advancement Study, NAVEDTRA 10052 (Series), is a very important publication for anyone preparing for advancement. This bibliography lists required and recommended Rate Training Manuals and other reference material to be used by personnel working for advancement. NAVEDTRA 10052 is revised and issued once each year by the Naval Education and Training Support Command. Each revised edition is identified by a letter following the NAVEDTRA number. When using this publication, be sure that you have the most recent edition.

If extensive changes in qualifications occur between the annual revisions of NAVEDTRA 10052, a supplementary list of study material may be issued in the form of a BUPERS Notice. When you are preparing for advancement, check with your Educational Services Officer or your Training Petty Officer to see whether changes have been made in the qualifications. If changes have been made, see if a BUPERS Notice has been issued to supplement NAVEDTRA 10052.

The required and recommended references are listed by rate level in NAVEDTRA 10052. If you are working for advancement to third class, study the material that is listed for third class. If you are working for advancement to second class, study the material that is listed for second class, and remember that you will also be examined on the references listed at the third class level.

NOTE: Personnel preparing for advancement will be examined on the TOTAL BIBLIOGRAPHY. Publications listed for a given paygrade frequently make specific reference to other publications. These specific referrals are part of the TOTAL BIBLIOGRAPHY. Emphasis must be placed on the military/technical TOTAL BIBLIOGRAPHY for each paygrade; examinations are based on it.

In using NAVEDTRA 10052, you will notice that some Rate Training Manuals are marked with an asterisk (*). Any manual marked in this way is MANDATORY—that is, it must be completed at the indicated rate level before you are eligible to take the Navy-wide examination for advancement. Each mandatory manual may be completed by passing the appropriate Nonresident Career Course that is based on the mandatory training manual; passing locally prepared tests based on the information given in the training manual; or in some cases, successfully completing an appropriate Class A School.

Do not overlook the front section of NAVEDTRA 10052 which lists the required and recommended references relating to the military standards/requirements for advancement. For example, all personnel must complete the Rate Training Manual, Military Requirements for Petty Officer 3 & 2, NAVPERS 10056 (Series), for the appropriate rate level before they can be eligible to advance.

The references in NAVEDTRA 10052 which are recommended, but not mandatory, should also be studied carefully. All references listed in NAVEDTRA 10052 may be used as source material for the written examinations at the appropriate rate levels.

Rate Training Manuals

There are two general types of Rate Training Manuals. Rating manuals (such as this one) are prepared for most enlisted rates, giving information that is directly related to the professional qualifications. Basic manuals give information that applies to more than one rate and rating. Basic Electricity, NAVPERS 10086 (Series), is an example of a basic manual because many ratings use it for reference.

Rate Training Manuals are revised from time to time to keep them up to date technically. The revision of a Rate Training Manual is identified by a letter following the NAVEDTRA number. You can tell whether any particular copy of a Rate Training Manual is the latest edition by checking the NAVEDTRA number and the letter following this number in the most recent edition of List of Training Manuals and Correspondence Courses, NAVEDTRA 10061 (Series). NAVEDTRA 10061 is a catalog that lists current training manuals and correspondence courses; you will find this catalog useful in planning your study program.

Rate Training Manuals are designed to help you prepare for advancement. The following suggestions may help you to make the best use of this manual and other Navy training publications when you are preparing for advancement.

1. Study the military requirements and the professional qualifications for your rate before you study the training manual, and refer to the occupational standards frequently as you study. Remember, you are studying the training manual in order to meet these occupational standards.

2. Set up a regular study plan. If possible, schedule your studying for a time of day when you will not have too many interruptions or distractions.

3. Before you begin to study any part of the training manual intensively, become familiar with the entire manual. Read the preface and the table of contents. Check through the index. Look at the appendixes. Thumb through the manual without any particular plan, looking at the illustrations and reading bits here and there as you see things that interest you.

4. Look at the training manual in more detail to see how it is organized. Look at the table of contents again. Then, chapter by chapter, read the introduction, the headings, and the subheadings. This will give you a clear picture of the scope and content of the manual. As you look through the manual in this way, ask yourself some questions: What do I need to learn about this? What do I already know about this? How is this information related to information given in other chapters? How is this information related to the occupational standards?

5. When you have a general idea of what is in the training manual and how it is organized, fill in the details by intensive study. In each study period, try to cover a complete unit–it may be a chapter, a section of a chapter, or a subsection. If you know the subject well, or if the material is easy, you can cover quite a lot at one time. Difficult or unfamiliar material will require more study time.

6. In studying any one unit–chapter, section, or subsection–write down the questions that occur to you. Many people find it helpful to make a written outline of the unit as they study, or at least to write down the most important ideas.

7. As you study, relate the information in the training manual to the knowledge you already have. When you read about a process, a skill, or a situation, try to see how this information ties in with your own past experience.

8. When you have finished studying a unit, take time out to see what you have learned. Look back over your notes and questions. Maybe some of your questions have been answered, but perhaps you still have some that are not answered. Without referring to the training manual, write down the main ideas that you have learned from studying this unit. Do not quote the manual. If you cannot give these ideas in your own words, the chances are that you have not really mastered the information.

9. Use Nonresident Career Courses (NRCC) whenever you can. These courses are based on Rate Training Manuals or on other appropriate texts. As mentioned before, completion of a mandatory Rate Training Manual can be accomplished by passing a Nonresident Career Course based on the Rate Training Manual. You will probably find it helpful to take other courses in addition to those based on mandatory training manuals. Taking a Nonresident Career Course helps you to master the information given in the training manual, helps you to see how much you have learned, and can serve for refresher study.

10. Think of your future as you study Rate Training Manuals. You are working for advancement to third class or second class right now, but someday you will be working toward higher rates. Anything extra that you can learn now will help you.

Nonresident Career Course

The Nonresident Career Course (NRCC), formerly called Enlisted Correspondence Course, for this Rate Training Manual (RTM) has been included at the back of the manual. Its purpose is to assist you in the training necessary to fulfill your job and advancement requirements; it will be of benefit to you when preparing for the Navy-wide Advancement Examinations; and it reflects the more important information in the manual.

Included in the course are learning objectives which state knowledges you will acquire by choosing the correct answer to each question or by restudying until you can choose the correct answer. The questions are teaching tools that point out important things in the Rate Training Manual. The Nonresident Career Course is an important part of the training package presented within these covers.

The answer sheets to the NRCC, referred to as IKOR (immediate knowledge of results) sheets, are a separate package and are not included with this Rate Training Manual. A separate errata sheet may be included with this training package. If present, it will inform you of any changes in the text of the RTM or the NRCC. For complete instructions on this NRCC, read the preliminary pages thoroughly before you proceed with the course.

QUALIFYING FOR ADVANCEMENT

In general, to qualify (be considered) for advancement, you must:

1. Have a certain amount of time in your present pay grade.
2. Demonstrate knowledge of material in your mandatory Rate Training Manual by making a suitable score on your command's test on the manual, by successfully completing the NRCC on the manual, or, in some cases, by graduating from an appropriate Navy school.
3. Demonstrate your ability to perform all the practical requirements for advancement by completing the Record of Practical Factors, NAVEDTRA 1414/1.
4. Be recommended by your commanding officer, after the petty officers and officers supervising your work have indicated that they consider you capable of performing the duties of the next higher rate by recommending you for advancement to the commanding officer.
5. For petty officer third and second candidates only, demonstrate knowledge of military subjects by passing the MILITARY/LEADERSHIP examination based on the military occupational standards for advancement (from NAVPERS 18068 (Series).

In addition to these requirements, to qualify for advancement you must demonstrate an understanding of the technical aspects of your rate by passing a Navy-wide advancement examination based on the occupational standards applicable to your rate (from NAVPERS 18068 (Series), those occupational standards listed at or below your rate level).

If you meet all of the above requirements satisfactorily, you are in a group from which advancements will be made.

WHO WILL BE ADVANCED?

Advancement is not automatic. Meeting all of the requirements makes you eligible but does not guarantee your advancement. Some of the factors that determine which persons, out of all of those qualified, will actually be advanced in rate are the score made on the advancement examination, the length of time in service, the performance marks earned, and the number of vacancies being filled in a given rate.

If the number of vacancies in a given rate exceed the number of qualified personnel, then all of those qualified will be advanced. More often, the number of qualified people exceeds the vacancies. When this happens, the Navy has devised a procedure for advancing those who are best qualified. This procedure is based on combining the three following personnel evaluation systems:

1. Merit rating system (Annual evaluation and C.O. recommendation)

2. Personnel testing system (Advancement examination score–with some credit for passing previous advancement exams)

3. Longevity (seniority) system (Time in rate and time in service).

Simply, credit is given for how much the individual has achieved in the areas of performance, advancement test, and seniority. A composite, known as the final multiple score, is generated from these three factors. All of the candidates who have PASSED the examination from a given advancement population are then placed on one list. Based on the final multiple score, the person with the highest multiple score is ranked first, and so on, down to the person with the lowest multiple score. For candidates for E-4, E-5, and E-6, advancement authorizations are then issued, beginning at the top of the list, for the number of persons needed to fill the existing vacancies.

Candidates for E-7 whose final multiple scores are high enough will be designated PASS SELBD ELIG (Pass Selection Board Eligible). This means that their names will be placed before the Chief Petty Officer Selection Board, a BUPERS board charged with considering all so-designated eligible candidates for advancement to CPO. Advancement authorizations for those being advanced to CPO are issued by this board.

Who, then, are the individuals who are advanced? Basically, they are the ones who achieved the most in preparing for advancement. They were not content to just qualify; they went the extra mile in their training, and through that training and their work experience they developed greater skills, learned more, and accepted more responsibility.

While it cannot guarantee that any one person will be advanced, the advancement system does guarantee that all persons within a particular rate will compete equally for the vacancies that exist and that the best qualified persons will be advanced.

EXAMINATION PROCEDURES

Examinations are given to candidates for advancement to E-4 through E-6 in February and August each year. E-7 through E-9 exams are given only once a year. The time and place of the examinations will be published in the Plan of the Day and in your station or unit paper. You must appear at the designated time and place in the uniform of the day and with your I D card. If you are to take the exam for ABF3, no other person taking that exam will sit near you. This helps ensure that all taking the exam have an equal chance. The examiner or a proctor will read to you the instructions to be followed. Be sure you listen to and follow these instructions carefully.

You will have three hours. Each question on the exam will have four possible answers from which to choose the correct one. Read each question carefully and all of the possible answers. If you know the correct answer, mark your answer sheet. If you do not know the answer, go to the next question. This will ensure that you have time to answer all the questions to which you know the answers in the time allotted. Each time you mark the answer sheet make your mark in the same number as the question.

After you have gone through the exam and answered all the questions to which you know the answers, go through the exam again and answer the questions that you can limit to two probably correct answers. Then you can spend the remaining time considering the questions about which you have the least knowledge and checking the questions and answers you have already completed. When the allotted time has passed, the proctor will collect the examination booklets and the answer sheets.

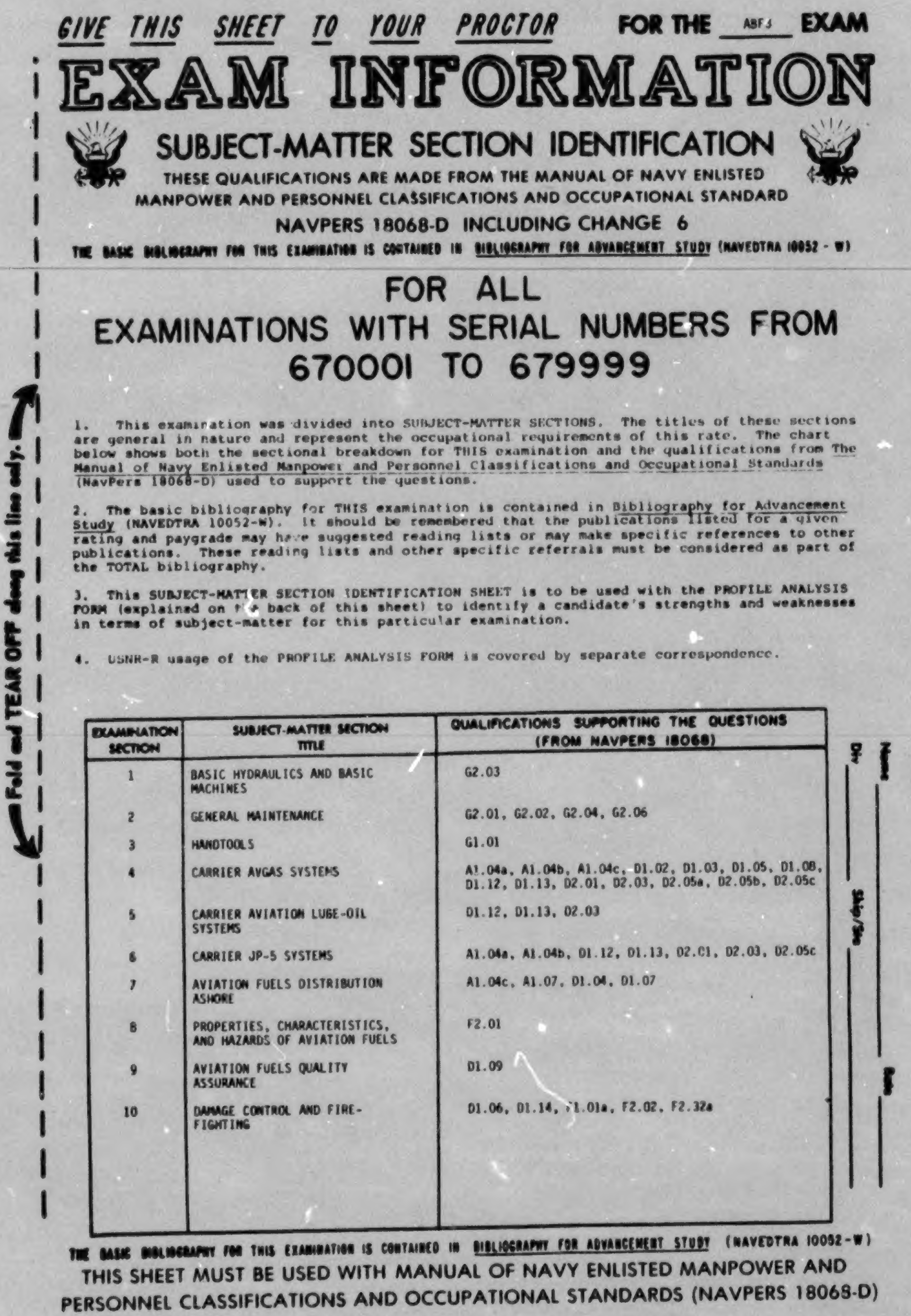
SUBJECT-MATTER SECTION IDENTIFICATION SHEET

The Subject-Matter Section Identification Sheet (fig. 1-3) is a tear-out sheet included in your Navy-wide advancement examination booklet. It is to be detached from the examination booklet upon completion of the examination and given to the exam proctor. This sheet indicates the subject-matter sections of the examination which represent the occupational requirements for the rate. The occupational standards used to support the examination questions are also indicated for each subject-matter section. This sheet will be retained by the Educational Services Officer (ESO) for purposes of command review upon receipt of the Profile Analysis Form. Both of these forms will be made available to you for your review at a date subsequent to the date of examination.

PROFILE ANALYSIS FORM

The Profile Analysis Form (fig. 1-4) is provided to all candidates two or three months after competing in the Navy-wide advancement examination. Normally, this form will be made available to you by your ESO with the Subject-Matter Section Identification Sheet, previously discussed. The Profile Analysis Form is to be used in conjunction with the Subject-Matter Section Identification Sheet to indicate your strengths and weaknesses for the particular examination in which you competed.

The Profile Analysis Form (refer to fig. 1-4) indicates the candidate's relative standing in Section 1 of the examination as being "A" (Average-middle). Section 1, as indicated on the Subject-Matter Section Identification Sheet, dealt with questions relating to "Basic Hydraulics and Basic Machines". You can,



GIVE THIS SHEET TO YOUR PROCTOR **FOR THE** ABF 3 **EXAM**

EXAM INFORMATION

SUBJECT-MATTER SECTION IDENTIFICATION

THESE QUALIFICATIONS ARE MADE FROM THE MANUAL OF NAVY ENLISTED MANPOWER AND PERSONNEL CLASSIFICATIONS AND OCCUPATIONAL STANDARD

NAVPERS 18068-D INCLUDING CHANGE 6

THE BASIC BIBLIOGRAPHY FOR THIS EXAMINATION IS CONTAINED IN BIBLIOGRAPHY FOR ADVANCEMENT STUDY (NAVEDTRA 10052 - W)

FOR ALL EXAMINATIONS WITH SERIAL NUMBERS FROM 670001 TO 679999

1. This examination was divided into SUBJECT-MATTER SECTIONS. The titles of these sections are general in nature and represent the occupational requirements of this rate. The chart below shows both the sectional breakdown for THIS examination and the qualifications from The Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards (NavPers 18068-D) used to support the questions.

2. The basic bibliography for THIS examination is contained in Bibliography for Advancement Study (NAVEDTRA 10052-W). It should be remembered that the publications listed for a given rating and paygrade may have suggested reading lists or may make specific references to other publications. These reading lists and other specific referrals must be considered as part of the TOTAL bibliography.

3. This SUBJECT-MATTER SECTION IDENTIFICATION SHEET is to be used with the PROFILE ANALYSIS FORM (explained on the back of this sheet) to identify a candidate's strengths and weaknesses in terms of subject-matter for this particular examination.

4. USNR-R usage of the PROFILE ANALYSIS FORM is covered by separate correspondence.

EXAMINATION SECTION	SUBJECT-MATTER SECTION TITLE	QUALIFICATIONS SUPPORTING THE QUESTIONS (FROM NAVPERS 18068)
1	BASIC HYDRAULICS AND BASIC MACHINES	G2.03
2	GENERAL MAINTENANCE	G2.01, G2.02, G2.04, G2.06
3	HANDTOOLS	G1.01
4	CARRIER AVGAS SYSTEMS	A1.04a, A1.04b, A1.04c, D1.02, D1.03, D1.05, D1.08, D1.12, D1.13, D2.01, D2.03, D2.05a, D2.05b, D2.05c
5	CARRIER AVIATION LUBE-OIL SYSTEMS	D1.12, D1.13, D2.03
6	CARRIER JP-5 SYSTEMS	A1.04a, A1.04b, D1.12, D1.13, D2.C1, D2.03, D2.05c
7	AVIATION FUELS DISTRIBUTION ASHORE	A1.04c, A1.07, D1.04, D1.07
8	PROPERTIES, CHARACTERISTICS, AND HAZARDS OF AVIATION FUELS	F2.01
9	AVIATION FUELS QUALITY ASSURANCE	D1.09
10	DAMAGE CONTROL AND FIRE-FIGHTING	D1.06, D1.14, F1.01a, F2.02, F2.32a

Name ______

Div ______

Ship/Sta ______

Rate ______

Fold and TEAR OFF along this line only.

THE BASIC BIBLIOGRAPHY FOR THIS EXAMINATION IS CONTAINED IN BIBLIOGRAPHY FOR ADVANCEMENT STUDY (NAVEDTRA 10052-W)

THIS SHEET MUST BE USED WITH MANUAL OF NAVY ENLISTED MANPOWER AND PERSONNEL CLASSIFICATIONS AND OCCUPATIONAL STANDARDS (NAVPERS 18068-D)

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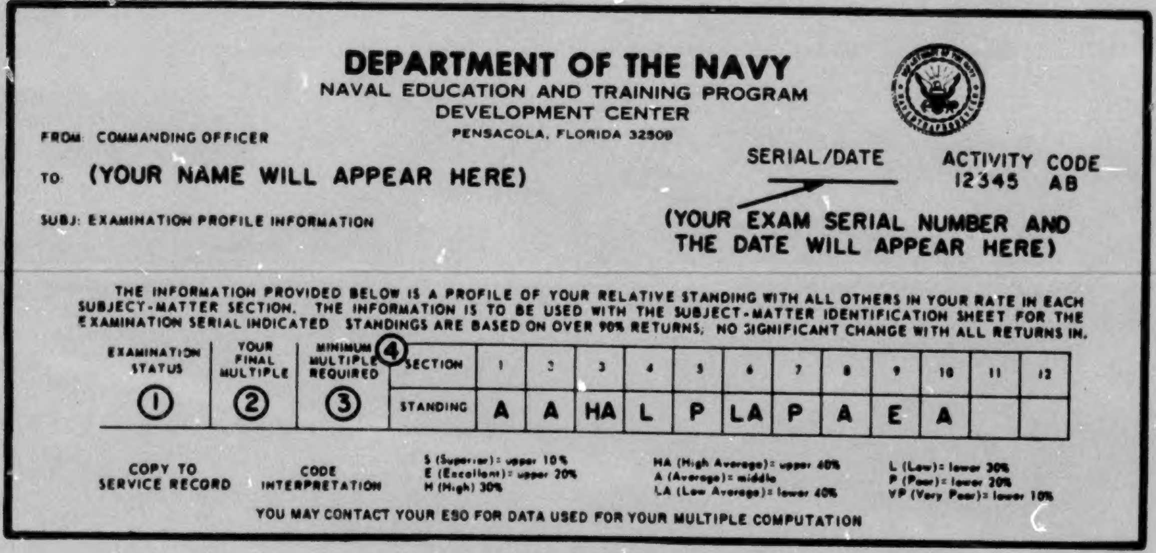
Figure 1-3.–Subject-Matter Section Identification Sheet.



DEPARTMENT OF THE NAVY
NAVAL EDUCATION AND TRAINING PROGRAM
DEVELOPMENT CENTER
PENSACOLA, FLORIDA 32509

FROM: COMMANDING OFFICER

TO: (YOUR NAME WILL APPEAR HERE)

SUBJ: EXAMINATION PROFILE INFORMATION

SERIAL/DATE

(YOUR EXAM SERIAL NUMBER AND THE DATE WILL APPEAR HERE)

ACTIVITY CODE
12345 AB

THE INFORMATION PROVIDED BELOW IS A PROFILE OF YOUR RELATIVE STANDING WITH ALL OTHERS IN YOUR RATE IN EACH SUBJECT-MATTER SECTION. THE INFORMATION IS TO BE USED WITH THE SUBJECT-MATTER IDENTIFICATION SHEET FOR THE EXAMINATION SERIAL INDICATED STANDINGS ARE BASED ON OVER 90% RETURNS. NO SIGNIFICANT CHANGE WITH ALL RETURNS IN.

EXAMINATION STATUS	YOUR FINAL MULTIPLE	MINIMUM MULTIPLE REQUIRED	④ SECTION	1	2	3	4	5	6	7	8	9	10	11	12
①	②	③	STANDING	A	A	HA	L	P	LA	P	A	E	A		

COPY TO SERVICE RECORD

CODE INTERPRETATION

S (Superior) = upper 10%
E (Excellent) = upper 20%
H (High) 30%

HA (High Average) = upper 40%
A (Average) = middle
LA (Low Average) = lower 40%

L (Low) = lower 30%
P (Poor) = lower 20%
VP (Very Poor) = lower 10%

YOU MAY CONTACT YOUR ESO FOR DATA USED FOR YOUR MULTIPLE COMPUTATION

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Figure 1-4.—Profile Analysis Form.

therefore, conclude that your standing was average, in comparison with the rest of the candidates, for Section 1 of the examination, "Basic Hydraulics and Basic Machines". The occupational standard used to support the questions on "Basic Hydraulics and Basic Machines" was G2.03. The same procedure should be followed for the remaining sections of the examination.

By the use of these two forms you will be able to determine those areas where additional study could assist you in future examinations.

SOURCES OF INFORMATION

One of the most useful things you can learn about a subject is how to find out more about it. No single publication can give you all the information you need to perform the duties of your rating. You should learn where to look for accurate, authoritative, up-to-date information on all subjects related to the military requirements for advancement and the professional standards of your rating.

Some of the publications described in this manual are subject to change or revision from time to time—some at regular intervals, others as the need arises. When using any publication that is subject to change or revision, be sure that you have the latest edition. When using any publication that is kept current by means of changes, be sure you have a copy in which all official changes have been made. Studying canceled or obsolete information will not help you perform efficiently or to advance; it is likely to be a waste of time, and may even be seriously misleading.

TRAINING FILMS

Training films available to naval personnel are a valuable source of supplementary information on many technical subjects. Training films are listed in the United States Navy Film Catalog, NAVAIR 10-1-777 (formerly NAVWEPS 10-1-777), published in 1969. Copies of this catalog may be ordered in accordance with the Navy Stock List of Forms and Publications, NAVSUP 2002. Monthly supplements to the Film Catalog are distributed to catalog holders. Check with your Training Petty Officer for the location of the nearest Film Catalog.

When selecting a film, note its date of issue listed in the Film Catalog. As you know, procedures sometimes change rapidly; thus, some films become obsolete rapidly. If a film is obsolete only in part, it may still be of some use.

EDUCATIONAL SERVICES OFFICER

One of the officers at your ship or station has been designated as the Educational Services Officer (ESO). The office of the ESO will be your point of contact for many of your educational and training needs. When you need a Rate Training Manual, a Basic Manual, or wish to order a Nonresident Career Course, this office will accommodate you.

The ESO office is provided each year with the QUAL/BIB sheets for each rating. These sheets indicate the latest occupational standards and bibliography for your rating and are for your personal use in preparing for advancement.

NOTE: You should check with your ESO to make certain that there have been no changes to the occupational standards as indicated by the latest change to NAVPERS 18068, or to the bibliography as indicated in the latest revision to NAVEDTRA 10052.

The ESO office also provides numerous other services of which you should avail yourself. It is to the advantage of each person in the Navy to utilize to the fullest extent the services provided by the ESO.

TRAINING PETTY OFFICER

A petty officer in your unit (squadron, station, division, department, or ship) has been designated the Training Petty Officer. He usually organizes and supervises the training for advancement in rating for the unit, while the petty officer under whom you work organizes and supervises the on-the-job training. A part of the Training Petty Officer's duties is to arrange for instructors and meeting places and set the time for lectures. He may have manuals you need to study for the advancement examination; if he does not have the material available, he will know where you can get it. He should be a big help to you in your program to become qualified for the next higher rate and well prepared for the advancement examination.

CHAPTER 2

GENERAL MAINTENANCE

An important responsibility of the ABF is the proper care of the machinery and equipment he uses. It is important that he know how to operate the equipment. It is also important that he know how the equipment functions in order to be able to make the adjustments and repairs required. He must also have a knowledge of the tools and equipment required to perform the repairs and adjustments.

Proper care includes painting when and where needed, preservation with various compounds of those parts which cannot be painted, and replacement of parts which are broken or worn. Besides knowing how to do all these things, the ABF must know how to obtain the materials and parts he needs, and how to find the technical information he must have.

Since it is beyond the scope of this training manual to present a detailed coverage of all these items, references to *Basic Training Manuals* and other publications are made at various points throughout this chapter. These manuals and other publications should be studied in conjunction with this chapter.

TOOLS

The ABF must have a well-rounded knowledge of many types of handtools and the purpose for which they are designed. One of the most important attributes that an ABF can have is the ability to use the tools that he will need for the everyday performance of his job, whether it be a simple and minor adjustment of a component or a major job such as the removal and overhaul of a pump.

The use of tools may vary; but safety, good care, and the proper stowage of tools never vary. In this section, various tools the ABF uses in the course of his duties in maintenance of the aviation fuels system are briefly described. The Rate Training Manual, *Tools and Their Uses*, NAVPERS 10085 (Series), also contains a description of most of the tools used by the ABF, together with detailed instructions for using them. The material given in this section is intended to supplement, rather than repeat, the information given in *Tools and Their Uses*.

HANDTOOLS

Handtools used in the repair of gasoline systems or in the repair of any equipment that is located where explosive material or flammable vapors are present must be made of nonsparking material. Nonsparking tools may be made of brass, lead, or aluminum. These tools are not as strong as steel tools, are bulkier, and not as easily used.

Some nonsparking tools are made of beryllium-copper alloy. These tools are almost as strong and of the same overall dimensions as steel tools. They are expensive and are issued only to ships having gasoline systems. Nonsparking tools are manufactured in most of the sizes and types as steel tools.

Steel tools may be used on equipment and machinery that are free from gasoline or gasoline vapors and that have been removed from the gasoline system into an area that is also free from gasoline vapors.

Special wrenches and tools are supplied by some of the equipment manufacturers. These wrenches and tools are designed to be used for specific purposes on the machinery where standard wrenches and tools cannot be used. They should be used only for those jobs for which they were designed.

Great care must be taken when doing repair work on components of the aviation fuels systems as most of the studs, bolts, and nuts as well as other parts of the component are made of brass. Brass does not have the tensile strength of steel and is much more prone to damage and breakage.

MEASURING TOOLS AND INSTRUMENTS

The measuring tools and instruments that the ABF will come in contact with and use the most are the feeler (thickness) gage, screw pitch gage, steel rule, a small micrometer, and various types of calipers. Proper usage of these tools and instruments is amply covered in *Tools and Their Uses*, NAVPERS 10085 (Series).

POWER TOOLS

Electrically driven power tools cannot be used in the repair of gasoline systems. The only exception is that they may be used if the gasoline system has been drained, flushed, steamed, and tested safe from explosive vapors. Power tools can be used in the shop on components that have been removed from the system and are free from gasoline vapors.

Pneumatically driven power tools are also restricted from use due to the steel accessories (tools) that must be used with them. Proper usage of power tools is covered in *Tools and Their Uses*, NAVPERS 10085 (Series).

SAFETY PRECAUTIONS

As previously mentioned, only tools made of nonsparking material are authorized for repairs in spaces where explosive or flammable vapors may be present. Never use electrically driven power tools in aviation gasoline spaces. For further information on the basic safety precautions for the use of handtools and power tools in the repair of gasoline systems, refer to chapter 9150 of *NAVSHIPS Technical Manual*, NAVSHIPS 250-000.

RIGGING EQUIPMENT

In repairing and maintaining a fuels system, the ABF must know something of rigging equipment and procedures to be able to handle the heavy equipment encountered.

BLOCKS AND TACKLES

A block is a frame of wood or steel fitted with sheaves (pulleys) over which a rope runs. A tackle is an assemblage of blocks and ropes for raising, lowering, or moving heavy loads. A simple tackle is an assemblage of blocks where a single rope is used. A compound tackle is an assemblage of blocks where more than one rope is used. See figure 2-1 for an illustration of a simple and compound tackle.

Types of Tackles

Tackles may be designated according to the number of sheaves in the blocks, or for the purpose for which they were used in the days of sailing ships. Designations for various types of tackle are given in figure 2-2.

Mechanical Advantage of Tackles

The mechanical advantage of a simple tackle is determined by counting the number of the

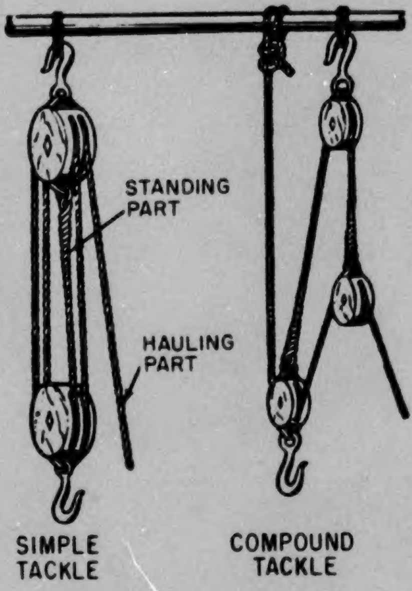

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Figure 2-1.—Blocks and tackles.

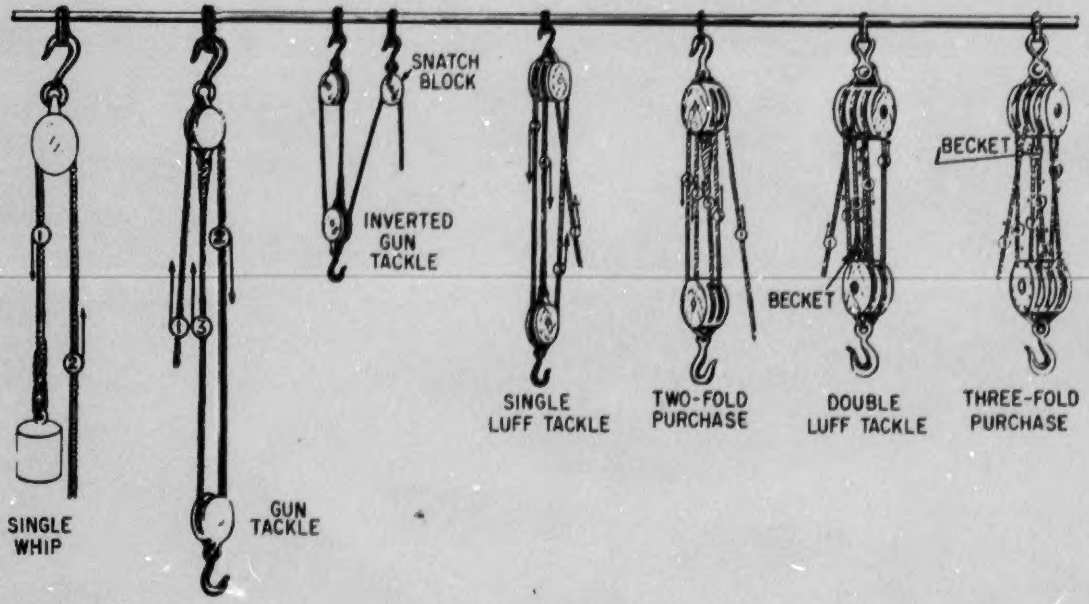

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Figure 2-2.—Types of tackles.

falls at the movable block. A gun tackle (fig. 2-2) has a mechanical advantage of two because there are two parts of the falls at the movable block. By inverting the tackle, it has an advantage of three.

To determine the amount of force (power) required to lift a given load by means of a given tackle, determine the weight of the load and divide by the mechanical advantage of the tackle.

Example:

1. Single luff tackle, mechanical advantage = 3.
2. Weight of a gasoline pump = 600 pounds.
3. 600 ÷ 3 = 200 pounds of force required to lift pump.

CHAIN HOISTS

Chain hoists are portable lifting devices suspended from a hook and operated by a hand chain. There are three types in common usage.

The differential hoist consists of three chain sheaves with an endless chain for lifting and operating. (See figure 2-3.)

The two upper sheaves are manufactured as one unit and rotate together. The smaller of these sheaves has one less chain link pocket. The difference in the diameter of these sheaves causes the lower sheave (hook) to raise or lower when the chain is rotated through the units. The direction the chain is pulled determines the raising or lowering of the hook. The difference in diameter of the sheaves is too small to overcome the overbalance; thus, the friction of the parts makes the hoist self-locking.

The spur-geared hoist gains its mechanical advantage from the difference in diameter of the spur gears (reduction gear ratio). (See figure 2-4.)

Two separate chains are used, one as a load chain and the other as the hand chain. The hand chain drives a pocketed chain wheel sheave that in turn drives the spur gears. The spur gears drive a single load sheave. One end of the load chain is attached to the swivel load hook. The chain then passes over the load sheave. The other end is

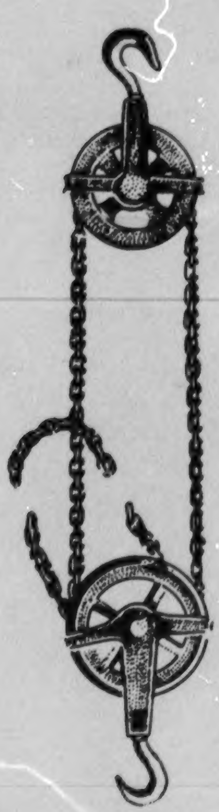

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Figure 2-3.–Differential hand chain hoist.

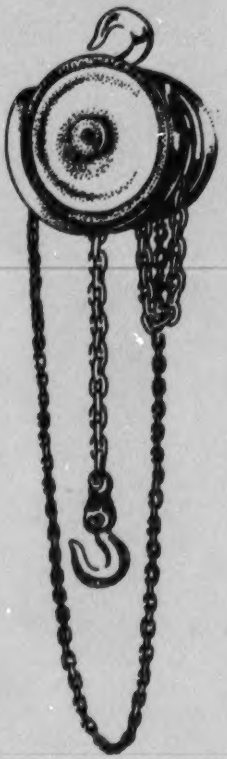

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Figure 2-4.–Spur gear hand chain hoist.

attached to the hoist frame. A mechanical brake, consisting of a ratchet and pawl or friction disc unit plate, is used to sustain the load. To lower, the operating chain is pulled in the reverse direction, slipping the friction brake or releasing the ratchet-pawl device.

The worm-geared hoist operates similar to the spur gear chain hoist except the reduction gearing is accomplished using a worm-gear drive. The lead (pitch) of the worm gear makes the hoist non-overhauling.

LEVER OPERATED CHAIN HOIST

One of the most widely used pieces of lifting equipment is the ratchet hoist. In more common terms it is usually referred to as a "come-along" (See figure 2-5.)

The ratchet hoist (come-along) has an operating handle similar to a ratchet wrench, hence its name. It is normally light in weight and comes in a variety of sizes, depending on the job to be done. A hoist has a ratchet and pawl or a friction disc brake incorporated in its mechanism to hold the load when the handle is released. Ratchet hoists are reversible so that the load may be raised or lowered. Ratchet chain hoists come equipped with the load chain either of the roller sprocket (bicycle) or link chain type.

Load chains should be lubricated and show no indication of binding. Do not exceed the load rating of the hoist or use extensions on the ratchet lever. Inspect load chains for wear, reduction in link bar diameter, and increase in unit lengths. Use manufacturer's data sheet or manual for reference.

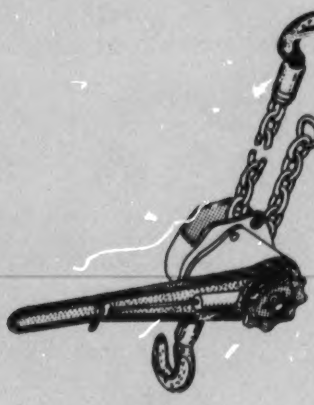

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Figure 2-5.—Come-along.

WIRE ROPE AND LINE

Wire ropes are built up of strands of wires laid together, the number of wires commonly used being 4, 7, 12, 19, and 37. Ordinarily the wires are laid into strands in the direction opposite to the twist of the strands into rope. When the wires and strands are laid in the same direction, the rope is known as lang-lay rope. Standard wire rope is made of 6-wire strands and a sisal or polypropylene core. Wire strands are laid around the core, either to the right or to the left, and the resulting rope is designated as right or left lay. The sisal or polypropylene core, saturated with lubricant provides little strength but helps lubricate the wires.

Wire rope is designated by the number of strands and the number of wires in the strand. For example, wire rope built up of 6 strands with 19 wires per strand is designated 6 x 19. Wire rope size is its largest diameter, measured from the high point of 1 strand to the high point on the strand on the opposite side.

The handling of wire rope requires more care than the handling of line. Wire rope must not be coiled or uncoiled like hemp line. When it is received upon a reel, the reel should be mounted upon a spindle or turn-table and the wire rope run off. All untwisting and kinking must be avoided. When a wire rope is to be cut, soft iron wire should be tightly served on each side of the place where the cut is to be made. This prevents the wire rope from untwisting.

For more details on the construction and handling, the proper uses, and the methods of attaching fittings and making splices in wire rope, refer to chapter 9270 of NAVSHIPS Technical Manual, NAVSHIPS 250-000.

FIBER LINE

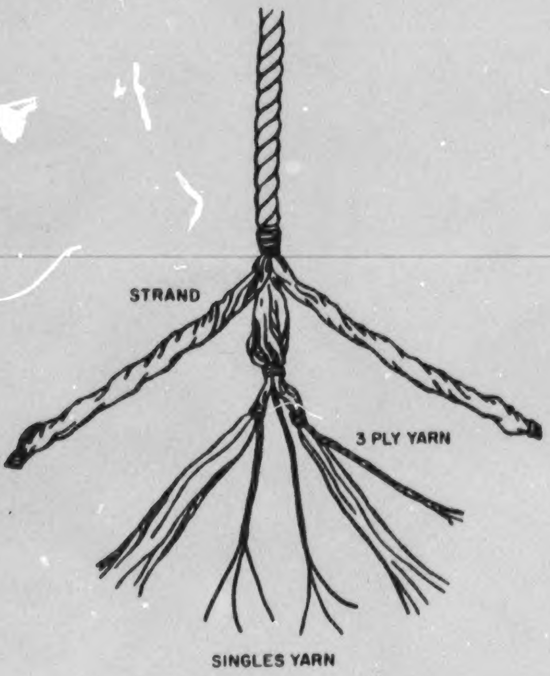
Fiber rope is referred to by seamen as line. Line has many uses throughout the Navy, varying from tiedowns to mooring lines, on anything from small boats to aircraft carriers. The size, construction, and material of the line depends on its end use.

Man's first line was made with nature's plant fibers. Today, even though synthetic fiber line is authorized for some shipboard uses, natural fiber line (manila line) continues to be used for many applications. However, this situation is expected to change since the world-wide supply of abaca fibers used to make manila line is rapidly dwindling.

Because of the impending shortage of the natural plant fibers used to make manila line, every effort should be made to conserve the limited supply. Last year the Navy required 2,000,000 pounds of manila line. If the projected use of manila line proves accurate, existing supply of the natural fibers needed to make manila line could be exhausted by July 1976.

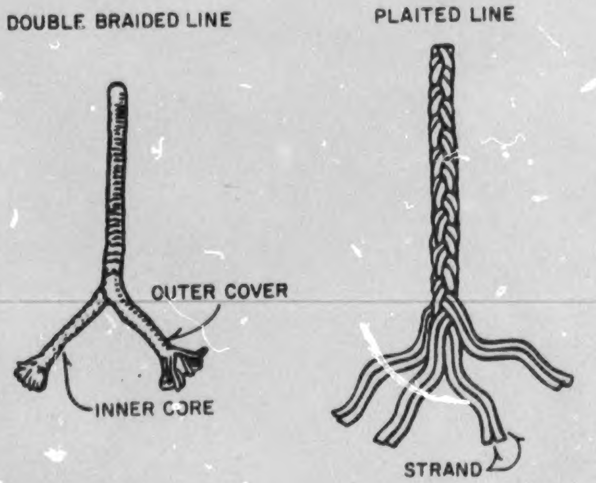
Description

Line used by the Navy may be made from any of a number of different kinds of natural or synthetic fibers—abaca, polypropylene, polyester, or nylon. Or it may be made from various combinations of these fibers, depending upon its use. Lines are classified by both their construction and their material. The most common line constructions currently used in the Navy are three-strand (fig. 2-6), double-braided, and plaited (fig. 2-7). Occasionally four-strand line will be seen. The most common synthetic fiber materials used in lines in the Navy are nylon, polypropylene, and polyester (Dacron).



197.82

Figure 2-6.–Makeup of fiber line.



197.83

Figure 2-7.–Double braided and plaited line.

In the manufacture of line, the fibers are twisted together in one direction to form "yarns." The yarns are twisted together in the opposite direction to form "strands," and the strands are again twisted together in the opposite direction to form "line." (See fig. 2-6.) Line may be manufactured either right-laid or left-laid. By far the greater part of line now used is "right-laid," so that the strands in the finished line spiral along in a right-handed direction as one looks along the line. Right-laid line must always be coiled down right-handed, or clockwise. Left-laid line when encountered, must be coiled down left-handed, or counterclockwise.

Line larger than 1 3/4 inches in circumference is designated as to size by its circumference in inches. Line is manufactured in sizes up to 21-inch hawsers. A "hawser" is any line larger than 5 inches, and is used for towing or mooring. As a general rule, a 12-inch line is about the largest line issued by the Navy for general shipboard use.

Line which is 1 3/4 inches or smaller in circumference is generally referred to as "small stuff" and is designated as to size by the number of yarns it contains, called threads in this case. To find the size of a piece of small stuff, a strand is opened out, the number of yarns it contains is counted, and the result multiplied by 3 for 3-strand stuff. The largest small stuff is 24-thread; it has 3 strands, each of which contains 8 yarns.

Nylon differs from other fiber lines in that it will stretch under load and yet recover to its normal length when tension is removed. A stretch of 25% its length is normal for three-strand under safe working loads. A stretch of 40 percent of its length is the critical point, and it will part at 50 percent stretch. This elongation at times may be a disadvantage, but it can be halved by doubling the lines. Nylon line can stand repeated stretching with no serious effect.

Nylon line that has been under heavy strain may develop glaze areas. This condition may be caused by paint or the fusing of fibers. In either case, the effect on the line's strength is negligible.

SYNTHETIC FIBER LINE CONSTRUCTIONS AND THEIR CHARACTERISTICS

LINE CONSTRUCTION	BREAKING STRENGTH	ABRASION RESISTANCE	STRETCH	RELATIVE COST	ROTATION UNDER LOAD
THREE STRAND	LOW	BEST	HIGH	LOW	YES
DOUBLE BRAIDED	HIGH	WORST	LOW	HIGH	NO
PLAITED	MEDIUM	MEDIUM	HIGHEST	MEDIUM	NO

(A)

SYNTHETIC FIBER LINE MATERIAL AND THEIR CHARACTERISTICS

LINE MATERIAL LINE MATERIAL	BREAKING STRENGTH	ABRASION RESISTANCE	STRETCH	RELATIVE COST	RESISTANCE TO SUNLIGHT
NYLON	HIGH	BEST	HIGH	MEDIUM	GOOD
POLYPROPYLENE	LOW	POOR	MEDIUM	LOW	BEST
POLYESTER (DACRON)	MEDIUM	GOOD	LEAST	HIGH	GOOD

(B)

197.84

Figure 2-8(A)(B).—Synthetic line construction, material and characteristics.

Nylon line will hold a good portion of its rated load even though a considerable number of the yarns have been abraded. Where such a condition is excessive but localized, the chafed section may be cut away and the ends spliced together for satisfactory reuse.

Three-strand nylon is spliced in a manner similar to manila, employing tape instead of seizing stuff for whipping the strands and line. Because of its smoothness and elastic properties, nylon requires at least two tucks more than manila. For heavy-load applications such as towing, a back tuck should be taken with each strand.

A coil of three-strand nylon line, unlike other fiber line, is not opened by pulling the end through the eye of the coil. It should be unreeled in the same manner as wire rope.

Determination of the appropriate line should be based on both the line's construction and its material. The three most common properties and materials are shown in fig. 2-8(A) (B). Using the information found in the figure, one can determine the construction and material needed for a particular application.

If, for example, a line must be able to withstand abrasion (abrasion being the condition a line is subjected to in a chock or around a capstan head), figure 2-8(A)(B) indicates that the best choice should be a three-strand nylon line. One of the characteristics listed for the three-strand nylon line is that the stretch is high. Stretch is a misunderstood characteristic in synthetic line. In some applications of a line excessive stretch is a disadvantage. In other applications stretch is advantageous. When a line is subjected to impact loading, as it is in towing, the more stretch the line has, the better it can absorb impact.

For example, if a 2,000-pound automobile is traveling at 60 miles per hour and it had to be stopped with a single piece of line 20 feet long, what diameter would that line have to be? By applying the appropriate mathematical equations and using the stretch curves one can determine that the diameter of the line would have to be:

1-5/8 inches if it were 3-strand or plaited nylon,

2-3/8 inches if it were double braided nylon, or

3-1/2 inches if it were a 6 X 37 IWRC Extra Improved plow steel wire rope.

Where the substitution of synthetic fiber line for manilla line is authorized, Table 2-1 provides the appropriate guidance for the substitution. Synthetic fiber line, of the three-strand construction, is authorized for the following shipboard applications: mooring, towing (where the synthetic fiber line has been authorized), and boat davits (where the type and construction of synthetic line has been specified). The list provided in Table 2-1 shall be utilized only where substitutions are authorized. (This list was taken from NAVSEC Notice 10450 of 17 March 1971).

This article provides shipboard personnel with a working knowledge and understanding of the various construction types and synthetic fiber materials of line. If a substitution for a manila line or another synthetic fiber line is mandatory or a new line use is found, the information in this article will provide guidance for the line choice.

Most of the nylon being used by the ABF is in the form of factory-made webbing and straps discussed later in this chapter.

Safety Precautions

1. Never overload a fiber line, nylon line or wire rope. A line or wire rope that has been subjected to loads greater than its safe working load may be seriously weakened and may break under a much lower load the next time it is used.
2. Never use wire rope on a block that is designed for manila or fiber line.
3. Always place cable clips on wire rope in the proper direction. (See fig. 2-9.) The U-bolt must go over the bitter end of the wire rope and the roddle over the standing part. Chapter 9270 of NAVSHIPS Technical Manual, NAVSHIPS 250-000, gives the correct spacing and number of clips required on different sizes of wire rope. This manual also gives methods of attaching other types of fittings to wire rope.
4. Always exercise extreme care when line is being paid out or eased from a securing device (bitts, capstans, bollards, cleats, etc.) For control in easing out, fill bit barrels with round turns as shown in (figure 2-10) and avoid using more than two figure-eight bends.
5. Always stand as far back as possible from a securing device being tended or worked to minimize the hazard of being pulled into the device should the line suddenly surge.

6. Never stand in the direct line of a line when it is being pulled or when it is under tension. A snap-back action inevitably occurs when a line parts (breaks) under tension. Whenever possible, your position should be 90 degrees from the direction of the tension force. (See fig. 2-11.)

7. Never rely on synthetic lines for knot holding ability. Some of the knots which are adequate for securing manila lines are not adequate for belaying or securing synthetic lines. The one exception is the bowline which offers reasonable security when bending together or securing synthetic lines.

The three following safety rules must be adhered to in all line handling operations regardless of the type of line being used.

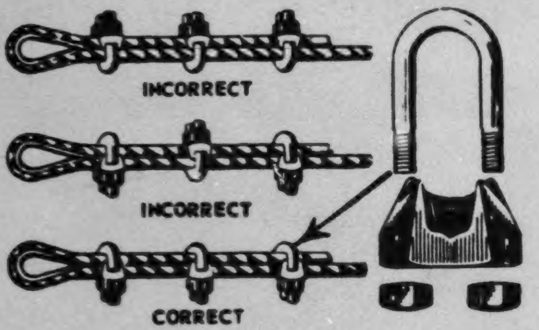
1. Never stand in the bight of a line. (See figure 2-12 for examples of bight area.)
2. Never attempt to increase the load on a line after the rigs have been two-blocked or tightened. Many injuries and fatalities have

Table 2-1.—Substitution table of synthetic line for manila line

MANILA ROPE SIZE (FED SPEC T-R-605)	NYLON ROPE (MIL SPEC MIL-R-17343)	POLYSTER ROPE (DACRON) (MIL SPEC MIL-R-30500)	POLYPROPYLENE ROPE (MIL SPEC MIL-R-24099)
5/8"	5/8"	5/8"	5/8"
3/4"	3/4"	3/4"	3/4"
1"	1"	1"	1"
1-1/8"	1-1/8"	1-1/8"	1-1/8"
1-1/4"	1-1/4"	1-1/4"	1-1/4"
1-1/2"	1-1/2"	1-1/2"	1-1/2"
1-3/4"	1-3/4"	1-3/4"	1-3/4"
2"	2"	2"	2"
2-1/4"	2-1/4"	2-1/4"	2-1/4"
2-1/2"	2-1/2"	2-1/2"	2-1/2"
2-3/4"	2-3/4"	2-3/4"	2-3/4"
3"	2-3/4"	2-3/4"	2-3/4"
3-1/4"	2-3/4"	2-3/4"	3"
3-1/2"	2-3/4"	2-3/4"	3"
3-3/4"	3"	3"	3-1/4"
4"	3-1/4"	3-1/4"	3-1/2"
4-1/2"	3-1/2"	3-1/2"	4"
5"	4"	4"	4-1/2"
5-1/2"	4-1/2"	4-1/2"	5"
6"	4-1/2"	5"	5-1/2"
6-1/2"	5"	5"	5-1/2"
7"	5-1/2"	5-1/2"	6"
7-1/2"	6"	6"	6-1/2"
8"	6"	6-1/2"	7"
8-1/2"	6-1/2"	6-1/2"	7-1/2"
9"	7"	7"	8"
10"	7-1/2"	8"	8-1/2"
11"	8-1/2"	8-1/2"	9-1/2"
12"	9"	9"	10"

Notes:

- All dimensions are circumferences.
- All ropes are three strand construction.
- This table established the rope size to be used only where official authorization exists to change from manila to a synthetic type rope.
- Publication of this table shall not be construed as authorization to change the type of rope used on any Navy application.
- Random rope substitutions can result in over-stressed components or change of system functional characteristics either of which could be hazardous to equipment and personnel.



197.1
Figure 2-9.—The correct and incorrect use of wire rope clips.

occurred as a result of personnel not observing this rule.

3. Always post a safety observer in every case where lines are being worked.

Webbing

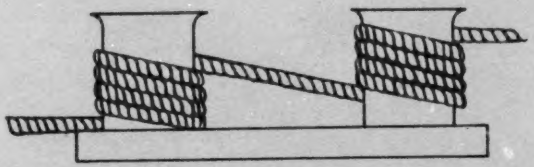
Webbing plays a very important role in many phases of naval aviation. For instance, webbing is used in barriers, parachute harnesses, cargo slings, safety belts, tiedown equipment, bomb hoists, strap wrenches, etc.

Webbing is manufactured in 5 colors in accordance with specifications listed in MIL-W-4088D: white, olive drab, sage green, yellow, and gray. It is available in strengths from 500 to 12,000 pounds breaking strength, and widths from 9/16 to 3 inches.

CORROSION CONTROL

THE NATURE OF CORROSION

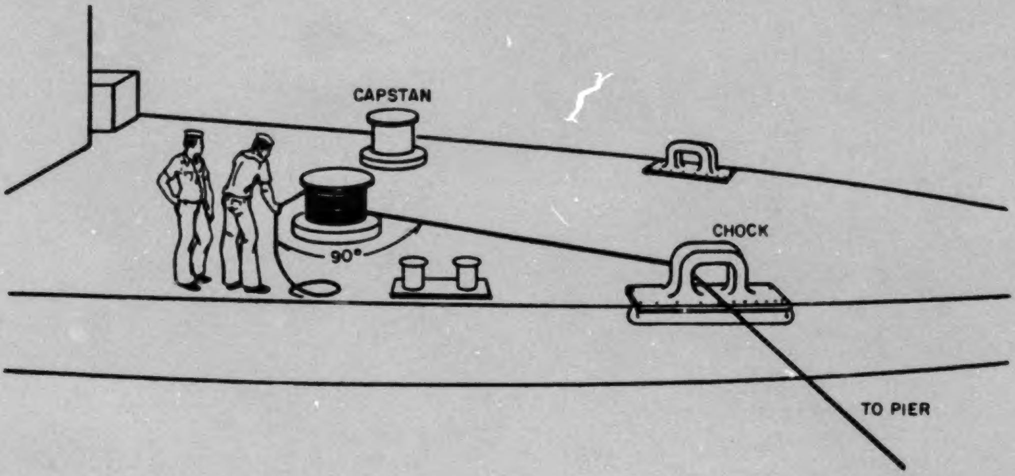
The study of corrosion involves the reactions taking place between a metal and its environment. By changing the characteristics of either the metal or the environment, corrosion can be controlled. It is mandatory, therefore, to invoke suitable corrosion control techniques into the objectives of any major maintenance program. Also, by learning the necessary skills and developing a good basic working knowledge of these corrosion control techniques, maintenance instructions and procedures can be applied with more efficiency which will result in reduced costs for repair or replacement of equipment.



197.85
Figure 2-10.—Bitts with round turns on barrels.

The corrosion of a metal is electrochemical in nature. The portion of the metal suffering corrosion loses electrons and is called the anode. The non-corroding metallic portion gains the electrons from the anode and is called the cathode. A solution (electrolyte) capable of conducting an electric current and a "metallic path" for conduction of electrons must also be present for the corrosion process to take place. In essence, there are four requirements which must be present in order for corrosion to take place, and all "four" must be present simultaneously. Remove any one requirement, and the corrosion process will stop. Figure 2-13 depicts a simplified electrochemical corrosion cell with the "four" main requirements. The basic cause of corrosion is the inability of metals to remain in their refined forms. Metals tend to revert to their natural states through the processes of corrosion. For example, iron placed in water containing oxygen will form hydrated ferric oxide, commonly known as "rust". Strangely enough, this "rust" has the same chemical formula as common iron ore. Thus, the rusting of iron is a very natural process of the metal reverting to its more stable ore-like compound.

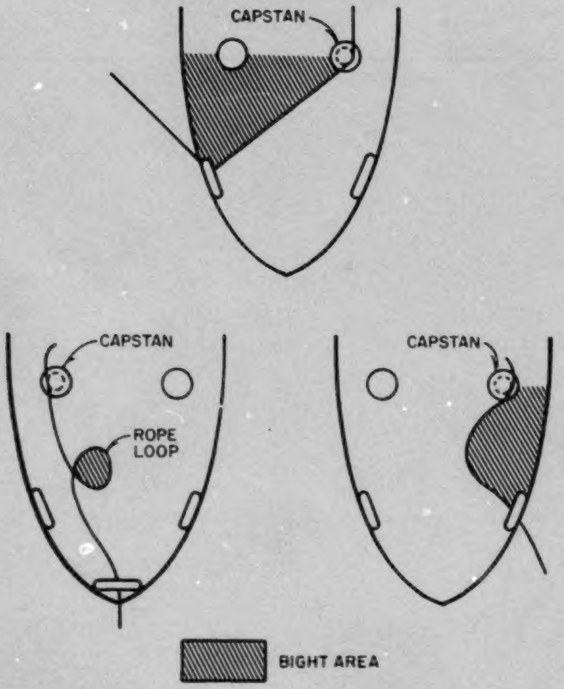
At this point it should be emphasized that the term "rust" refers only to iron and iron-base


CAPSTAN
90°
CHOCK
TO PIER

197.86

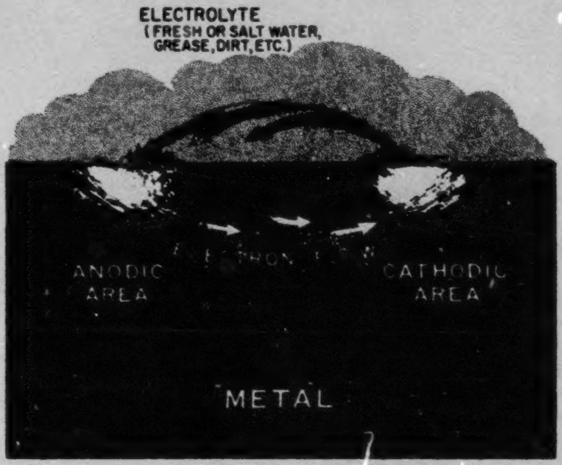
Figure 2-11.—Line handler and safety observer 90° from tension force.

alloys (usually called ferrous alloys). The term "rust" is never used to describe the corrosion of non-ferrous metals, such as aluminum, copper, magnesium and their alloys. For non-ferrous metals, the terms "copper oxide", "aluminum oxide", and other specific metal oxides, are used to describe corrosion.


CAPSTAN
CAPSTAN
ROPE LOOP
CAPSTAN
▨ BIGHT AREA

197.87

Figure 2-12.—Area within a bight where a person should not stand.


ELECTROLYTE
(FRESH OR SALT WATER, GREASE, DIRT, ETC.)
ELECTRON FLOW
ANODIC AREA
CATHODIC AREA
METAL

213.49

Figure 2-13.—Simplified corrosion cell.

Table 2-2.–Corrosion of common metals

Metal	Type of Corrosion Attack	Appearance of Corrosion Products
Aluminum Alloy	Surface pitting, Intergranular and exfoliation	White or gray powder
Copper base alloy, brass, bronze	Surface and intergranular corrosion	Blue to blue-green
Magnesium alloy	Highly susceptible to surface pitting	White powdery snow-like mounds on surface
Iron-base stainless steel (300-400 series)	Tendency toward pitting in marine environment. 300 series more corrosion resistant than 400 series.	Corrosion apparent by rough surface.
Nickel-base alloys (Monel, Inconel)	Good corrosion resistance. In some cases pitting may be observed in crevices.	Green powdery deposit
Iron-base non stainless steel	Pitting and intergranular	Reddish-brown oxide (rust)

Appearance, Types and Characteristics of Corroded Metals

Different metals are affected to different degrees, and the corrosive attack takes many different forms. Table 2-2 summarizes the type of attack and the corroded appearance of respective metallic materials commonly used in Navy service.

Common Types of Corrosion

There are many forms of corrosion, the type depending on the metal involved, its size and shape, anode/cathode ratio, its specific function, environmental conditions, and the stress levels applied to the metal. The most common types are described as follows:

1. Direct Surface Attack.–Although this type of corrosion is the most common and probably the least damaging of all types of corrosion, it should nevertheless be treated as soon as possible in order to prevent more serious damage. The rusting of iron-base alloys and the tarnishing of silver are common examples of this form of corrosion attack.

2. Dissimilar Metal Corrosion (Galvanic).–When two dissimilar metals are coupled to each other in a corrosive environment, the more active metal becomes the anode and corrodes.

As an example of galvanic corrosion, where an aluminum alloy is joined to a copper alloy (such as bronze or brass), the aluminum alloy will corrode since it is more active than the copper alloy. It should also be stressed that the degree of corrosion attack taking place depends on the relative activity of the two different metal surfaces–the greater the spread between the metals, the more accelerated will be the attack on the anode (more active metal).

3. Pitting.–This is a localized type of corrosion attack which appears as cavities on the

surface of a metal. Such metals as aluminum alloys, steels, and stainless steels are particularly affected in this manner. Certain inhomogeneities between areas on a metal surface usually are responsible for this type of corrosion attack. Pits may be of different sizes and shapes.

4. Intergranular Corrosion.–Under certain conditions, this type of corrosion attack occurs along the grain boundaries of susceptible ferrous and non-ferrous alloys. If the cooling rate of the heat treatment procedure is too slow, the alloying elements may combine to form compounds along the grain boundaries instead of within the grains of the metal. If these compounds happen to be anodic to the adjacent grain material (cathode), cracking will then occur along these grain boundaries. In the case of aluminum alloys, if the grains are greatly elongated in one direction and the attack progresses far enough, corroded layers of metal can actually be peeled off. This type of attack is usually referred to as "exfoliation".

5. Crevice Corrosion.–This type of corrosion is usually in the form of pitting and caused by an entrapped solution containing either dissolved oxygen or charged metal particles producing anodic and cathodic areas. Preventing this type of corrosion involves the use of sealants and caulking materials, eliminating stagnant pools of corroding solutions, keeping certain areas dry and clean, and avoiding the creation of crevices during manufacture or repair operations.

6. Fretting Corrosion.–This type of corrosion occurs at the interface between highly loaded metal surfaces in contact where vibration produces localized deformation of the metal surfaces. Attack may be greatly minimized by excluding air between the surfaces and applying a suitable lubricant.

7. Stress Corrosion Cracking.–The simultaneous action of a sustained "tensile stress" in the presence of a corrodent will produce in susceptible alloys stress corrosion cracking. Cracks may follow along the grain boundaries (intergranular) or may propagate across the grains (transgranular). With respect to copper base alloys, this type of corrosion attack is referred to usually as "Season cracking". A common procedure to overcome or minimize stress corrosion cracking involves a pretreatment of shot peening the metal surface. This mechanical stress relief procedure induces "compressive stresses" which oppose the residual tensile stresses on the metal surface rather than sustained static loads which are partly responsible for stress corrosion cracking.

PRESERVATION OF EQUIPMENT

Preservation of equipment and spare parts is a continuous job aboard ship. Therefore, moving parts must be kept free of corrosion by application of the proper lubricant. Parts which cannot be painted and which will be used infrequently should be coated with a preservative compound which can be removed readily with solvents or wiped off. Dirt and rust should be removed before applying preservatives or lubricants.

PAINTING

In the Navy, paint is used primarily for the preservation of surfaces. It seals the pores of wood and steel, arrests decay, and helps prevent the formation of rust. Paint also serves a variety of other purposes. It is valuable as an aid to cleanliness and sanitation, both because of its antiseptic properties and because it provides a smooth, washable surface. Paint is also used to reflect or to absorb light, or to redistribute light. For example, light-colored paint is used in the interior of the ship to distribute natural and artificial light to the best advantage. These same properties of reflection and absorption, incidentally, make camouflage painting possible.

The color an item is to be painted depends upon its function and location. For instance, gasoline system equipment is painted yellow, and catapults are painted machinery gray.

As you know, there are many different kinds of paint. For example, you cannot use the same type of paint on the deck topside as on the bulkhead in the Captain's cabin. There is different paint made for almost every purpose. Paint primers for topside exteriors should not be used for underwater areas. Interior paints are formulated to provide "non-flaming" properties. Good commerical grade enamels may look better and clean more readily, but they are usually not fire retardant. Detailed instructions concerning the proper paint to use for each job may be found in chapter 9190 of NAVSHIPS Technical Manual, NAVSHIPS 250-000, or in applicable NAVSHIPS instructions.

The most important single factor in securing good paint performance is proper surface preparation. Dirt, oil, grease, rust, and mill scale must be removed completely, and the surface must be thoroughly dry.

Equipment used to prepare surfaces includes handtools, power tools, sandblasters and shot blasters, soap (or detergents) and water, and various paint and varnish removers.

The following items must not be painted:

1. Activating mechanisms of electrical safety devices and control switchboards on machinery elevators.
2. Bell pulls, sheaves, annunciator chains, and other mechanical communication devices.
3. Composition metal water ends of pumps.
4. Condenser heads and outside surfaces of condensers when of composition metal.
5. Dry sprinkling piping within magazines.
6. Exposed composition metal part of any machinery.
7. Glands, stems, yokes, toggle gear, and all machined external parts of the valves.
8. Heat exchanger surfaces of heating or cooling equipment.
9. Identification plates.
10. Joint faces of gaskets and packing surfaces.
11. Lubricating gear, such as oil holes, oil or grease cups, lubricators, and surfaces in contact with lubricating oil.
12. Lubricating oil reservoirs.
13. Machined metal surfaces of reciprocating engines or pumps.
14. Metal lagging.
15. Rods, gears, universal joints, and couplings of valve operating gear.
16. Rubber resilient elements of insulation mounts.
17. Sliding feet of turbines and boilers.
18. Springs.
19. Strainers.
20. Threaded parts.
21. Turbine casing joints, nuts, and bolts.
22. Working surfaces.

Each year the Navy spends thousands of dollars developing and testing finishes for specific surfaces. Consequently, you have available the best material to be had anywhere. If you prepare the surface properly, use the recommended finish, and apply the finish correctly including the proper number of coats and film thickness, you will have a first-rate job which will last a long time. Do not use any material not provided by or methods not recommended by the Navy.

For details on the uses and types of paint, surface preparation, and methods of paint application, refer to chapter 9190 of NAVSHIPS Technical Manual, NAVSHIPS 250-000.

COLOR CODES OF PIPING (SHIPBOARD)

Piping systems aboard ship are normally painted to match the surrounding compartment. The piping identification is made by labeling the pipe with the type of fluid flowing through it and an arrow for indicating the direction of flow.

JP-5 piping should be painted purple in interior spaces and painted to match the surrounding area on the exterior of the ship.

Exterior gasoline piping and valves should be painted the same color as the surrounding structure. Exterior valves are identified by painting a 90°-section of the handwheel or a 4-inch yellow band on operating levers. No other valves should be so painted. Interior valves and piping should be yellow, and no other valves or pipes on the ship should be so painted. The moving parts of a valve should never be painted.

BLUEPRINTS AND DRAWINGS

The ABF operating, maintaining, and repairing fuel systems must be able to read blueprints and drawings. Checking a schematic-type drawing of a piping system makes it much easier to locate an individual pipe, flange fitting, valve, or other fitting or equipment. Blueprints also indicate the types of fittings or equipment.

As you advance in rate, you will be expected to be able to make sketches and drawings. A sketch is made freehand and shows rough outlines and only those details that are necessary to visualize a system or an object.

A drawing is similar to a sketch, but it is made with mechanical drawing instruments and drawn to scale.

A blueprint (may be a black line print, etc.) is a duplicate of a drawing or sketch. Usually, only accurate drawings are blueprinted. These blueprints are furnished by the manufacturers of the machinery installed aboard your ship, and also by the commands concerned with the building and maintenance of the ship on which you are serving.

Mechanical drafting is a special language and is defined as follows: "A language which uses lines, symbols, dimensions, and notations to accurately describe the form, size, kind of material, finish, and construction of an object."

Blueprints, also called prints, make it possible for you to understand what is wanted. In a comparatively little space, they give a great deal of information in a universal language that may be recognized readily by personnel with suitable background in blueprint reading.

Of the many types of blueprints you will use aboard ship, the simplest one is the plan view. This is a blueprint which shows the position, location, and use of the various parts of the ship. You will use plan views to find your duty and battle stations, the sickbay, the barbershop, and other parts of the ship.

In addition to plan views you will find aboard ship other blueprints called assembly prints, unit or subassembly prints, and detail prints. These prints show various kinds of machinery and mechanical equipment.

Assembly prints show the various parts of the mechanism, how the parts fit together, and their relation to each other.

Individual mechanisms, such as motors and pumps, will be shown on unit or subassembly prints. These show location, shape, size, and relationships of the parts of the subassembly unit.

Assembly and subassembly prints are used to learn operation and maintenance of machines, systems, and equipment.

Symbols are a very important aspect of blueprint reading. This is particularly true of piping system prints.

PIPING SYMBOLS

You should become familiar with some of the more common piping symbols. Figure 2-14 lists some of the symbols used in the blueprints and diagrams of fuel systems. A complete listing of mechanical (piping) symbols is given in MIL-STD-17A, the current symbol standard.

The fittings and valves listed in figure 2-14 have flange type joints. Figure 2-15 gives the symbols for all of the various types of joints—flanged, screwed, welded, and soldered.

SCHEMATIC DIAGRAMS (PIPING)

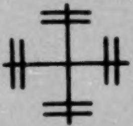
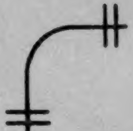
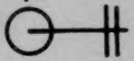
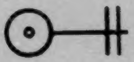
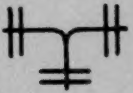
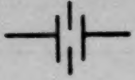
A schematic diagram shows by means of single lines and symbols how the parts of a system are connected for the operation of the system. They are normally used to trace piping systems and their functions without actually describing the shape, size, or location of the components or parts. Each component is represented by a symbol and once these symbols are learned the piping schematic diagram is easy to read.

Figure 2-16 is a good example of a piping diagram of an aviation fuels station. As may be seen from this example, diagrams do not indicate the location of individual components within the station, but do locate the components with respect to each other within the system.

The weight of the lines in the diagram give no indication as to the size of the piping. On most diagrams the size of the piping is indicated by a numeral. Components that have no standard symbol are normally labeled. The direction of flow through the piping is indicated by arrows.

Diagrams of this type are used extensively in ship's piping manuals and Ship's Information Books (SIB).

For greater details on diagrams, drawings, and blueprints, and their interpretation, a study of *Blueprint Reading and Sketching*, NAVPERS 10077 (Series) should be made.

PIPE FITTINGS, VALVES AND PIPING	SYMBOLS
CROSS, STRAIGHT SIZE	
ELBOW, 90-DEGREE	
ELBOW, TURN DOWN	
ELBOW, TURN UP	
ELBOW, DOUBLE BRANCH	
ORIFICE FLANGE	
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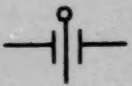
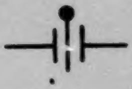
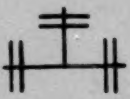
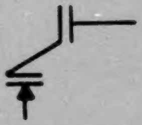
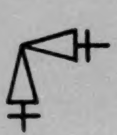
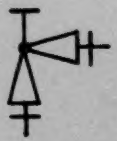
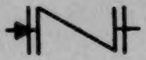
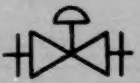
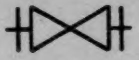
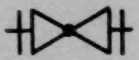
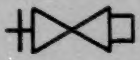
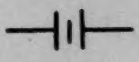
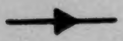
OPEN	
CLOSED	
TEE, STRAIGHT SIZE	

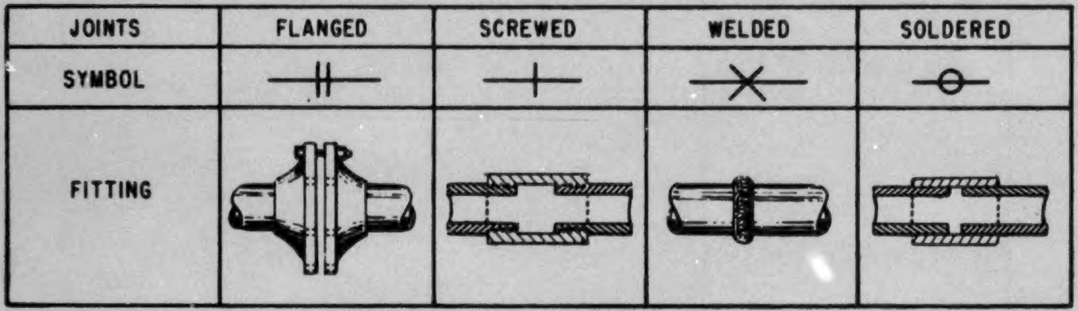
PIPE FITTINGS, VALVES AND PIPING	SYMBOLS
ANGLE CHECK VALVE	
ANGLE GATE VALVE	
ANGLE GLOBE VALVE	
CHECK VALVE	
DIAPHRAGM VALVE	
GATE VALVE	
GLOBE VALVE	
GATE HOSE VALVE	
UNION	
DIRECTION OF FLOW	

197.2

Figure 2-14.—Piping and fitting symbols.

FUNDAMENTALS

For the purposes of safety and understanding of the operations of some of the fueling equipment, the ABF should have an understanding of the fundamentals of electricity, hydraulics, and basic machines. The information given in this chapter is not intended to replace the information on these subjects given in Basic Training Manuals.

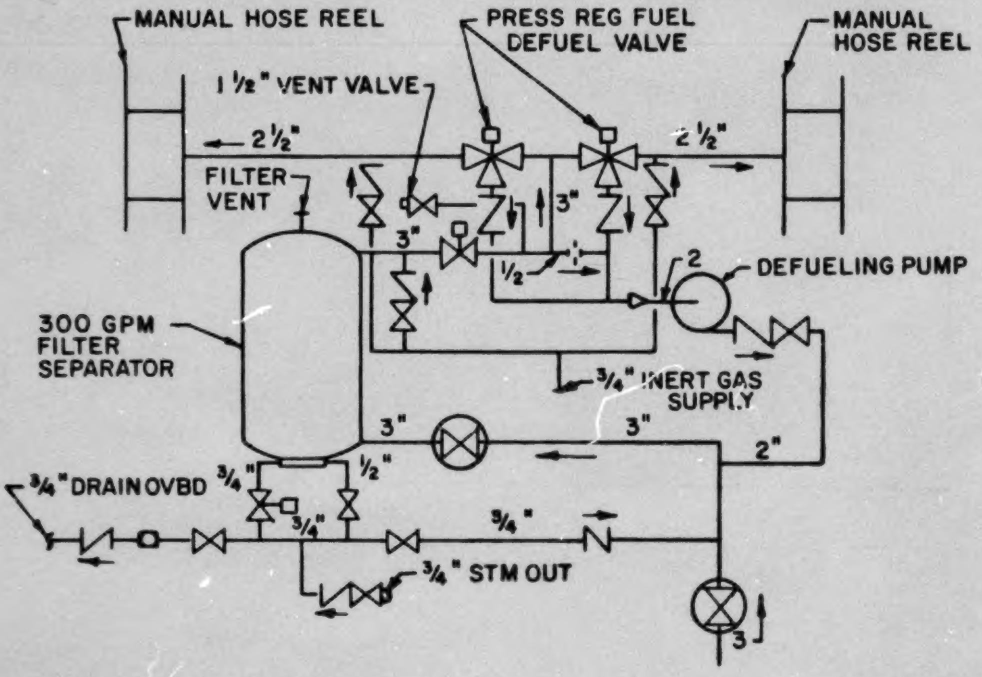

JOINTS
FLANGED
SCREWED
WELDED
SOLDERED
SYMBOL
FITTING

197.3

Figure 2-15.—Joint symbols.

ELECTRICITY

The ABF must be aware of some of the dangers of electricity in the operation of fuels systems and in the refueling of aircraft. Since the ABF is primarily concerned with static electricity and radiofrequency electromagnetic radiation, the discussion here is limited to these two hazards. For a detailed discussion on the fundamental concepts of electricity, the ABF


MANUAL HOSE REEL
PRESS REG FUEL DEFUEL VALVE
MANUAL HOSE REEL
1 1/2" VENT VALVE
2 1/2"
2 1/2"
FILTER VENT
3"
3"
1/2
2
DEFUELING PUMP
300 GPM FILTER SEPARATOR
3/4" INERT GAS SUPPLY
3"
3"
2"
3/4" DRAIN OVBD
3/4"
1/2"
3/4"
3/4"
3/4" STM OUT
3

197.4

Figure 2-16.—Schematic diagram of an aviation fuels station.

should study *Basic Electricity*, NAVPERS 10086 (Series).

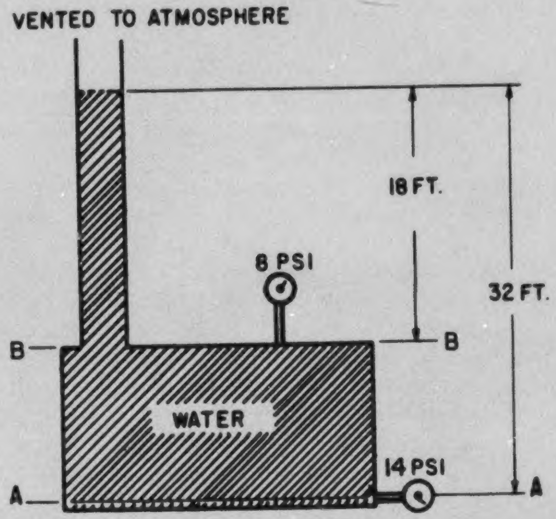
Static Electricity

The early Greek philosophers were aware of the fact that when amber was rubbed with fur, both the amber and the fur, if carefully insulated, had properties after the rubbing that they did not have before. For example, the amber attracted the fur afterward but not before. The rubbing process mentioned "rubs" electrons off the fur onto the amber, thus giving the amber a surplus of electrons and leaving the fur with a deficiency of electrons.

The fundamental fact of static electricity is that similarly electrified bodies repel, whereas oppositely electrified bodies attract each other. When oppositely charged bodies are brought near each other and the charge is sufficiently great, the flow of electricity across the air gap between the two bodies will produce a spark. Static electricity of considerable voltage may be accumulated by the friction of gasoline flowing through a rubber hose when the nozzle is not properly grounded. A spark may be formed when the nozzle is brought in contact with another object. The flow of air over an aircraft may also cause a considerable voltage to accumulate in the aircraft structure, making it imperative that the aircraft be grounded to neutralize the electric charge before refueling the aircraft.

RF Radiation

Radiofrequency electromagnetic radiation may produce arcs and heat small metallic objects (steel wool, steel chips, etc.) to the kindling temperature of combustible material with which they may be in contact. The electrical arcs occur due to the voltages induced in the metallic objects in the path of the radiation. The transmitting antennas involved may be those on the ship, aircraft, an adjacent ship, or land-based equipment. For more details on this subject, see chapter 9670, paragraph .308, of the NAVSHIPS Technical Manual, NAVSHIPS 250-000.



197.5
Figure 2-17.—Effect of height of liquid on liquid head.

HYDRAULICS

Hydraulics is the branch of physics having to do with the mechanical properties of liquids. As the science of hydraulics covers a very large field, only those applications of hydraulics that are related to fuels systems are discussed in this chapter. For further details on hydraulics, a study of *Fluid Power*, NAVPERS 16193 (Series) should be made.

Shapelessness of Liquids

While solids have a definite shape, liquids have no outer form of their own. They quickly conform in shape to their containers. Because of their own shapelessness, we can lead liquids almost anywhere in a pipe or a hose by means of gravity or by applying forces to them.

Pascal's law states that a pressure set up in a liquid acts equally and undiminished in every direction throughout the container. This pressure acts at right angles to the containing surfaces.

Thus, in figure 2-17 if the column of liquid standing on a square inch A at the bottom of the tank weighs 16 pounds, a pressure of 14 pounds per square inch will be exerted in every direction at A. The liquid resting on A will push equally downward and outward. But the liquid on every other square inch of the bottom surface is also pushing downward and outward in the same way, so that the pressures on different areas are in balance. At the edge of the bottom the pressures act against the wall of the tank, which everywhere must be at least strong enough to resist them with a force equal to the push. Every square inch of the bottom of the tank must be strong enough to resist the downward pressure of the liquid resting on it. The same balance of pressures exists at every other level in the tank but lessens as it approaches the surface.

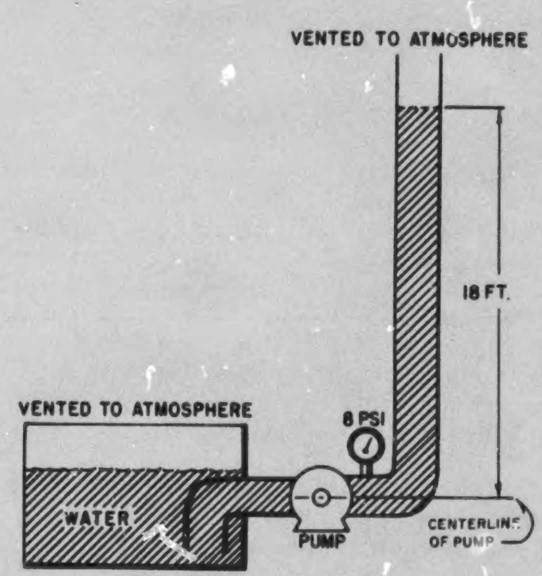
One of the consequences of Pascal's law is that the shape of the container in no way alters pressure relations. Thus, in figure 2-17, if the pressure due to the weight of the liquid at one point on the horizontal line B is 8 pounds per square inch, the pressure will be 8 pounds per square inch everywhere at level B in the container.

Pressure due to a liquid's weight will depend, at any level, upon the vertical height of liquid from that level to the surface of the liquid. The vertical distance between two horizontal levels in a liquid is known as the head of the liquid at the lower level with respect to the higher. The width of the containers has no effect on the pressure exerted at any level.

The weight of a liquid also affects the height to which a pump will deliver a volume of liquid. This height is known as the pump's total head. This total head may be expressed in pressure (psi) or in feet. The higher the total head, the greater the pressure must be to deliver a given volume of liquid. Figure 2-18 shows the relationship between the height attained and the pressure that a pump will produce.

Hydrostatic Shock (Water Hammer)

When the flow in a pipe is too quickly interrupted, as for example, by the sudden closing of a valve, the onward motion of the liquid is suddenly halted. The inertia of the liquid causes a sudden high pressure, the effect of which is like a hammer blow. This sets up a pressure wave moving at about a mile per second surging back and forth through the system alternately stretching and compressing the pipe. This condition can do great damage to a piping system if the flow rate or pressure in the system is very high.



197.6

Figure 2-18.—Total head of a pump.

Venturi

A venturi is a device that can be used to measure the velocity of flow of a fluid (liquid or gas) through a piping system. Essentially, a venturi tube (fig. 2-19) is a short, straight pipe section or throat between two tapered sections. It operates on Bernoulli's principle, which states that when a fluid flowing through a tube reaches a constriction, or narrowing of the tube, the velocity of the fluid flowing through the constriction is increased and its pressure is decreased. For flow measurement, use is made of the static-pressure difference between the inlet and throat. The tapered sections of the venturi streamline the flow and prevent turbulence in the flow path.

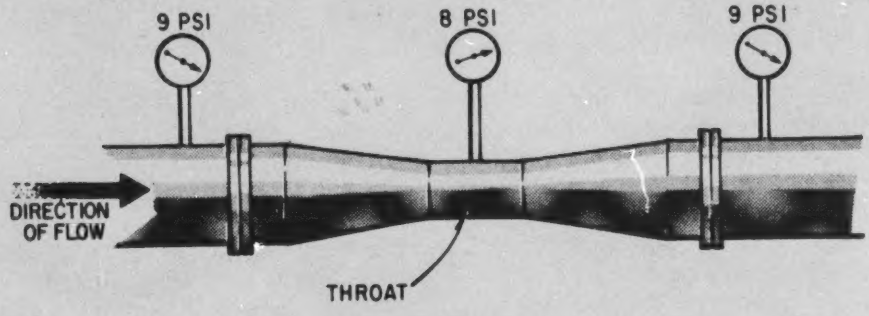


Figure 2-19.—Venturi tube.

Eductor

An eductor is a jet type pump that makes use of water under pressure to pump additional water. If a stream of water under pressure is driven into a chamber having an exit, as it rushes out through the exit it will carry some of the contents of the chamber with it. This will lower the pressure in the chamber. This is an example of the venturi effect. If the chamber is connected to an open supply of water, a pumping action is set up, since atmospheric pressure on the surface of the water will force some of the water up into the inlet pipe and into the chamber.

BASIC MACHINES

Basic machines are not covered in this training manual other than those already discussed under block and tackle and hydraulics. The Basic Training Manual, *Basic Machines*, NAVPERS 10624 (Series), covers in detail such [illegible] machines as block and tackle, wheel and [illegible] inclined plane, screws, and gears. It discusses the fundamentals of hydrostatic principles and hydraulic mechanisms, explains the concepts of work and power, and differentiates between the terms "force" and "pressure."

COMPRESSED GASES AND STEAM

For safety purposes, the ABF should be familiar with the characteristics of the various types of compressed gases used aboard ship and at naval air stations. He must know the hazards involved in handling these products and be aware of the necessary safety precautions. The gases described in this section are commonly found aboard ship and at various naval activities ashore.

CARBON DIOXIDE

CO_2 is the chemical symbol for carbon dioxide. This colorless, ordorless gas is 1.52 times as heavy as air. It can be condensed into a colorless liquid and stored in this state, under pressure, in cylinders. When the cylinder valve is opened, gaseous CO_2 escapes and, due to the rapid drop in temperature and pressure, forms carbon dioxide snow. This snow, compressed into blocks or cubes, is what we know as "dry ice." Dry ice in solid form and at atmospheric pressure, evaporates, remaining at -110°F until it has disappeared. It is excellent for certain refrigeration uses.

Because it will neither support combustion nor form explosive mixtures, CO_2 is one of the chief fire extinguishing agents in use today. It is also used for inflatable gear such as life rafts and vests, and a propellant or expelling agent.

Carbonated soft drinks contain carbon dioxide dissolved in water and kept under pressure in the container. When the pressure is relieved, CO_2 bubbles will rise to the surface.

There are many natural carbon dioxide wells in the earth's surface. Yellowstone National Park has several of these wells, and in some of the park's caves the CO_2 is so dense that animals are suffocated when they wander into them. Since CO_2, in addition to being heavier than air, is both invisible and odorless, it presents a particular hazard. As in the caves, it will tend to collect in low, unventilated places which might well be below decks on shipboard, for instance. The fact is obvious that the more of any gas, poisonous or not, that is present, the less breathable oxygen there will be present. Men going into these conditions or places, or left there, run the risk of smothering to death.

Small percentages of carbon dioxide will cause drowsiness and perhaps headaches. Three percent in the air doubles breathing effort, and five percent causes panting. Eight percent causes marked distress and ten percent causes unconsciousness very quickly.

Treatment of exposed personnel includes removal from the CO_2 laden atmosphere, artificial resuscitation, administering of oxygen, and keeping the patient warm and quiet.

NOTE: Do not enter an area or compartment containing hazardous amounts of carbon dioxide without being equipped with a breathing mask or an independent supply of air; then enter only when equipped with a lifeline and with an assistant standing by outside the area or compartment. CAUTION: The Oxygen Breathing Apparatus (OBA) must NEVER be used in aviation fuel spaces. The danger of an explosion exists anytime the cannister comes in contact with aviation fuel.

GASEOUS OXYGEN

Oxygen makes up almost one-half of all matter that we know. Water contains by weight about 89 percent oxygen. Clay, sand, limestone, and granite contain about 50 percent. One-fifth by volume of the air is oxygen. This is the only occurrence of free oxygen, this one-to-five mixture in the air; elsewhere, it is found in compounds.

Oxygen is a colorless, ordorless gas slightly heavier than air, which does not itself burn, but which supports the combustion of other things. Even steel will burn in pure oxygen.

Gaseous oxygen is normally contained in cylinders and identified as one of two types—(1) aviator's breathing oxygen or (2) industrial or technical oxygen. There is absolutely no difference in the purity of the oxygen itself in these two types. The only difference is in the moisture content of the cylinders. Cylinders containing aviator's breathing oxygen have been dried inside, before being charged, to prevent failure of breathing apparatus due to the formation of ice under high altitude freezing conditions.

To simplify the supply system, aviator's breathing oxygen is the only kind stocked by ships and is used on shipboard for welding and cutting operations as well as for breathing purposes.

Industrial or technical oxygen, supplied for nonshipboard use in welding and cutting operations, can be and is used for breathing purposes, other than aviation, because its purity is identical with that of aviator's breathing oxygen, and freezing conditions at low altitudes either do not exist or can be eliminated. The safety rules that you as an ABF must observe for gaseous oxygen are as follows:

1. Never permit oil, grease, or other readily combustible substances to come in contact with oxygen cylinders, valves, regulators, gages, and fittings. Contamination with hydrogen, oils, or grease may result in a serious fire or explosion.
2. Never lubricate oxygen valves, regulators, gages, or fittings with oil or other flammable substances. Do not handle oxygen cylinders or apparatus with oily hands or gloves. Use NAVSEA approved lubricants and thread compounds only.
3. Never use oxygen from a cylinder without reducing the pressure through a suitable regulator.
4. Use only approved oxygen regulators, hose, and other appliances.
5. Never attempt to use oxygen cylinders for other than oxygen service.
6. Never use oxygen as a substitute for compressed air. It is dangerous to use oxygen for pneumatic tools, for starting diesel engines, for building up pressure in oil reservoirs, for paint spraying, for blowing out pipelines, and similar purposes for which compressed air is normally used.
7. Never use compressed oxygen or any other compressed gas for cooling the body or for blowing dust from the clothing.

NITROGEN

For our purposes, nitrogen is considered to be an inert gas. It is not completely inert, for there are many nitrogen compounds such as the nitrates used in fertilizers and explosives. However, nitrogen is very slow to combine chemically with other elements under normal conditions. This is clearly seen when you consider that four-fifths of the atmosphere is always nitrogen, and therefore it is always around when things are happening, yet it rarely combines chemically under ordinary conditions. The oxygen in the air gets directly into fires, into rust, into living things, and into the oxidation of many substances, but nitrogen supports no fires, no living things, and causes no rust or decay of most of the things with which it comes in contact. By chemical and electrical processes it can be taken from the air and combined with other substances. Such processes are known as "nitrogen fixation."

In the Navy, nitrogen is used for pressure-operated mechanisms such as recoil systems, for testing and purging pipe lines, as a fuel- blanket for the AvGas cofferdams, pressurizing aircraft tires, and for preservation packing.

Nitrogen is slightly lighter than air and is neither flammable nor explosive. It is not poisonous, but unless oxygen is mixed with it, it is an asphyxiant.

The safety precautions for compressed nitrogen are similar to those for compressed air.

Always call nitrogen by its proper name. Never call nitrogen "air".

There are two classifications for nitrogen, oil-free nitrogen and oil-pumped nitrogen. This distinction should be properly observed since only oil-free nitrogen may be used for certain applications such as purging oxygen systems.

COMPRESSED AIR

Air as charged in Navy-owned cylinders is normally oil- free, and when it is supplied dry, it is suitable for use in applications where a low water-vapor content is necessary.

The safety precautions with regard to compressed air are much the same as for the other compressed gases. Of course, compressed air is neither poisonous nor flammable, but at the same time you should not become careless in handling it. Compressed air tanks, lines, and fittings have exploded injuring men and property. Literally thousands of careless men have blown dust or harmful specks into their eyes by the negligent handling of compressed air outlets. Because compressed air seems so safe in comparison with the other gases, do not let overconfidence lead to your own or some other person's injury. Never break a compressed air (or other compressed gas) connection without first bleeding fusion from the system.

General Rules for the Stowage of Compressed Gases

1. In general, weather-deck stowage is provided for flammable and explosive gases. However, in specific cases below-deck stowage is approved depending on the particular type, mission, and arrangement of the vessel. In such cases, these approved locations are shown on the ship's drawings.
2. In compartments designed for stowage of flammable or explosive gases, the installation of portable electric wiring and equipment is not permitted.
3. Flammable materials, especially grease and oil, must be kept out of the stowage space, and the space be kept clean.
4. Each individual cylinder must be securely fastened in the vertical position (valve end up) by means such as metal collars.
5. When compressed gas is stowed on the weather deck, the following precautions must be observed:
    - a. Oxygen cylinders and chlorine stowed on the weather deck must not be in close proximity to fuel-gas cylinders.
    - b. The stowage area must be as remote as practical from navigating, fire control, and gun stations.
    - c. Other flammable materials, especially grease and oil, must be kept out of the stowage area.

General Rules for Handling Compressed Gas Cylinders

1. Cylinders that contain flammable and/or explosive gases must be handled with particular

care. Every effort should be made to avoid their being dropped or allowed to strike forcefully against each other or any other object. Every precaution must be taken to prevent bumping or striking the discharge valves during handling operations.

2. The cylinder valve outlet cap and the cylinder valve protecting cap must both be in place when cylinders are being handled.

3. When loading or transferring cylinders, especially when using a crane or derrick, the cylinders must be secured in a cradle, suitable platform, rack, or special container such as a sandbag. Electromagnets must never be used. A cylinder moved by hand should be tilted slightly and rolled on its bottom edge, without dragging or sliding. Hooks or lines through valve protection caps must not be used for hoisting cylinders. Cylinders frozen to the deck, or otherwise fixed, must not be pried loose with crowbars or similar tools.

STEAM

Steam is water with enough heat added to it to convert it from a liquid to a gaseous state. Steam is colorless, odorless, and tasteless. When heat is added to water in an open container and it reaches a temperature of 212° F at an atmospheric pressure of 14.7 psi, steam forms; but it quickly mixes with air and condenses or cools back to water. This water is in such fine particles that it is dissolved into the air.

When heat is added to water in a closed container (boiler), the steam that forms (after a temperature of 212° F) rapidly builds up a pressure. The boiling temperature, as a result of the pressure increases, gets higher. The steam in the boiler stays at the same temperature as the boiling water beneath it, and contains moisture. This is known as saturated steam.

Superheated steam is steam which is hotter than the boiling temperature of water. For example, in the boilers when steam has 250° F of superheat, the actual temperature is the boiling temperature plus 250° F. At a pressure of 600 psi, the boiling temperature of water is 489° F. With 250° F superheat added, its actual temperature is 739° F, producing an almost perfect dry gas. The hotter this gas is kept, the longer its working force is retained.

SAFETY PRECAUTIONS

Many men confront dangers in their workaday lives, and a number of safety precautions are applicable to all personnel at one time or another.

A shipboard environment introduces factors affecting safety that are not found ashore. Underway refueling, multiship exercises, storms, and other situations require men at sea to be constantly vigilant. An accident at sea can involve all hands in a matter of seconds. Every man, therefore, must be continually alert to hazardous conditions.

You need not learn each safety precaution by heart, but you should know what each one means and why it should be observed. Although most of the precautions given here are from a shipboard viewpoint, many of them apply equally well ashore. The hazards presented by improperly grounded electrical tools, for example, are the same everywhere. Remember: Accidents seldom just happen; they are caused. Another point to remember is never let familiarity breed contempt. Hundreds of men have been injured by accidents, and many have died because of their injuries. Most of those accidents could have been prevented had the men involved heeded the appropriate safety precautions.

RESPONSIBILITIES

The Commanding Officer shall require that persons concerned are instructed and drilled in all applicable safety precautions and procedures, that these are complied with, and that applicable safety instructions, or extracts therefrom, are posted in appropriate places. In any instance where safety precautions have not been issued or are incomplete, he shall issue or augment such safety precautions as he deems necessary, notifying, when appropriate, higher authorities concerned.

It is the responsibility of supervisory personnel to ensure that their subordinates are instructed in and carry out the applicable safety precautions for their work and work areas.

Each individual is responsible for knowing, understanding, and observing all safety precautions applicable to his work and work area. In addition, he is responsible for the following:

1. Each individual shall report for work rested and emotionally prepared for the tasks at hand.
2. He shall use normal prudence in all his functions, commensurate with the work at hand.
3. He shall report any unsafe condition, or any equipment or material which he considers to be unsafe, and any unusual or developing hazards.
4. He shall warn others whom he believes to be endangered by known hazards or by failure to observe safety precautions, and of any unusual or developing hazards.
5. He shall report to his supervisor any accident, injury, or evidence of impaired health occurring in the course of work.
6. He shall wear or use the protective clothing and/or equipment of the type required, approved and supplied for the safe performance of his work.
7. He shall report for work suitably clothed for his assigned tasks.
    a. Suitable clothing is that normally worn by members of the trade or profession.
    b. Certain hair styles and beards are hazardous around machinery and open flame and may interfere with vision or use of breathing devices. They shall be suitably restrained in caps or nets, or altered/removed.
    c. Safety shoes or foot protection devices, including nonsparking and nonslip shoes, shall be worn when hazards so indicate.
    d. Jewelry, loose scarfs, and ties shall not be worn when they might subject the wearer to additional hazards.
    e. Individuals requiring eye correction, hearing aids, or prosthetic devices to assure prompt perception and avoidance of hazards, must use such devices while at work.

PUBLICATIONS

For the ABF, the most important publications are the various operation and maintenance manuals covering each piece of machinery or equipment he uses. He should study these manuals until he can find, without fumbling, any information contained in them. The manuals contain a wealth of valuable information: The proper lubricant to use on each moving part; the name and part number of every component, down to and including rubber O-rings; and the exact steps to be taken in removing a particular part for replacement.

The manuals are arranged so that particular information is easily found. Usually the first section of the manual will contain a general description of the equipment, a discussion of functions and operation, and an enlarged view of the entire equipment. Each major component or group in the enlarged view will have a title. This title will appear in the index, showing the page where detailed information may be located.

The detail sections of a manual will contain further enlarged views, prints, and schematics. Each part will appear in one or more drawings, and will have an illustration number. For instance, suppose the particular part you require appears in figure 181, along with twenty other parts. Each part has a number on the illustration, ranging from 1 through 21. The one you need is 17. The illustration number for the part you want is 181-17. The illustration number will appear in numerical order in a listing of all parts shown in each figure. On the line with the illustration number will appear the correct nomenclature for the part, and the part number or drawing number.

Part numbers are vital to securing replacement parts, for they are the principal means by which your supply department can identify, procure, and issue the exact part you require. A mistake in a part number can cause delays in getting the equipment back into operation, and unnecessary expense in shipping the wrong material. If you are in doubt about the part number, take the book with you to supply for assistance.

COORDINATED SHIPBOARD ALLOWANCE LIST (COSAL)

The COSAL is a supply management document in that it provides the supply officer with listings of what material to stock in his storerooms, and how many of each item must be carried aboard ship.

The COSAL does not include ship's store stocks, resale clothing, bulk fuels, subsistence items, expendable ordnance, or repair parts for aircraft.

There are various types of COSAL; each one is designed for specific equipment. The ABF is primarily concerned with the Ships Parts Control Center (SPCC) COSAL. This COSAL covers hull, mechanical, electrical, and ordnance equipment.

The segments of the SPCC COSAL are divided into parts and sections as follows:

Part I

Summary of Effective Allowance Parts/ Equipage Lists (SOEAPL)
Index–Section A
Index–Section B

NOTE: Included in Part I is an introduction section which gives detailed descriptions of the parts and contents of the COSAL, information that will aid you in using the COSAL, and procedures for making corrections.

Part II

Section A. Allowance Parts List (APL)
Section B. Allowance Equipage List (AEL)

Part III

Section A. Storeroom Items (SRI) Stock Number Sequence List (SNSL)
Section B. Operating Spare Items (OSI) Stock Number Sequence List (SNSL)
Section C. MEC Codes
Section D. Alternate Number Crossreference to Stock Number
Section E. General Use Consumables List (GUCL)
Section F. Forms and Publications

When using the COSAL, the ABF is primarily interested in the procedures for inventorying the equipage he is responsible for, and ordering repair parts and special tools required to maintain this equipment.

Using the SPCC COSAL

Once you become familiar with the indexes, you will find the COSAL easy to use. The best way to gain this familiarity is by studying the COSAL for your ship. Read the entries in both the A and B Indexes; then see how they provide a cross-index by using the same entries but in a different sequence. As you study the entries, refer to the introduction for the meanings of abbreviations that you do not understand.

Table 2-3 has been prepared to show the types of information you can obtain from the COSAL and, using what you already know, where to find it.

Validating the COSAL

Validation is the physical inventory of all equipment on board, and matching that inventory with the records of installed equipment listed in the SPCC COSAL.

Individual ships are responsible for assuring that COSAL segments reflect the actual equipments installed. To assure an accurate and complete COSAL, ships must validate the COSAL by physical comparison of the installed components with the technical data contained on individual APLs, COSAL Indexes, or applicable validation aids, and report the results of such comparison to the allowance list maintenance activity.

SPCC validation aids consist of a new "B" Index and a set of 5" X 8" cards covering every equipment/component listed in the index. The cards contain the equipment/component nomenclature, APL number, service application, quantity as shown in the index, plus complete characteristics as shown on the APL. Complete instructions are included in the validation package.

The actual work of sighting each item, comparing the nameplate data with that shown on the validation aid, and making necessary corrections is normally done by the ship's department that is responsible for maintaining the equipment. The supply officer usually is responsible for coordinating the validation and reporting all corrections to the inventory control points (ICPs) as per the instructions. These corrections cover equipment removed from the

Table 2-3.–Using the SPCC COSAL

You want to know	You already know	Consult
NSN of repair part	Nomenclature of part	APL
NSN of repair part	Reference number	Alternate number cross-reference to stock number or APL/AEL
APL/AEL number	Name of equipment/component	Index, Section A
APL/AEL number	Service application of equipment/component	Index, Section B
Storeroom allowance of a repair part	NSN	SNSL-SRI
Allowed quantity of an equipage item	NSN	SNSL-OSI
All related components of an equipment/system	Service application	Index, Section B
Total quantity of specific equipment/component installed	Name of equipment/component	Index, Section A
Appropriate "On Board Allow." column of AEL	Equipage nomenclature	Index, Section A
Appropriate "On Board Allow." column of AEL	Service application	Index, Section B
Total Quantity of a repair part in use	NSN	SNSL-SRI
Technical data of an equipment/component	APL/AEL number	APL/AEL

ship, new equipment received, changes in nameplate data, changes in quantity, or changes to service application.

The important thing to remember about validation–your new COSAL will only be as good as your validation. The corrections you send back to SPCC will be used to correct the master index, and from that your new COSAL will be prepared.

SHIPS PARTS CONTROL CENTER

The ABF will find in his association with supply that most of his spare parts and other supply functions are under the cognizance of NAVSEA and in most instances are kept in the general store section of supply. His primary dealing with supply involves the submission of chits for the drawing of spare parts.

Used in conjunction with the COSAL is the Federal Supply Catalog Navy Master Cross Reference List, which converts part numbers to stock numbers and stock numbers to part numbers.

The ABF will be concerned with material assigned to the management of the Ships Parts Control Center, and designated cognizance symbol H material. This consists of ships repair parts required for the support of equipment used in the gasoline systems, such as gasoline pumps, sea water pumps, electric motors, and distribution system, including spare parts.

The nonsparking tools are cognizance symbol 9G and are in the general stores division of supply.

The general stores division of the supply department of the ship handles the cognizance symbol H material for the SPCC.

The replacement parts you need will be carried or procured by the general stores division, S-1. It is important to know where to obtain the parts you need. This division maintains many storerooms, most of which will be of no concern to you. Learn which ones are used to stow the material in which you are interested, the normal hours of operation, and how to obtain material outside the normal hours.

PROCUREMENT

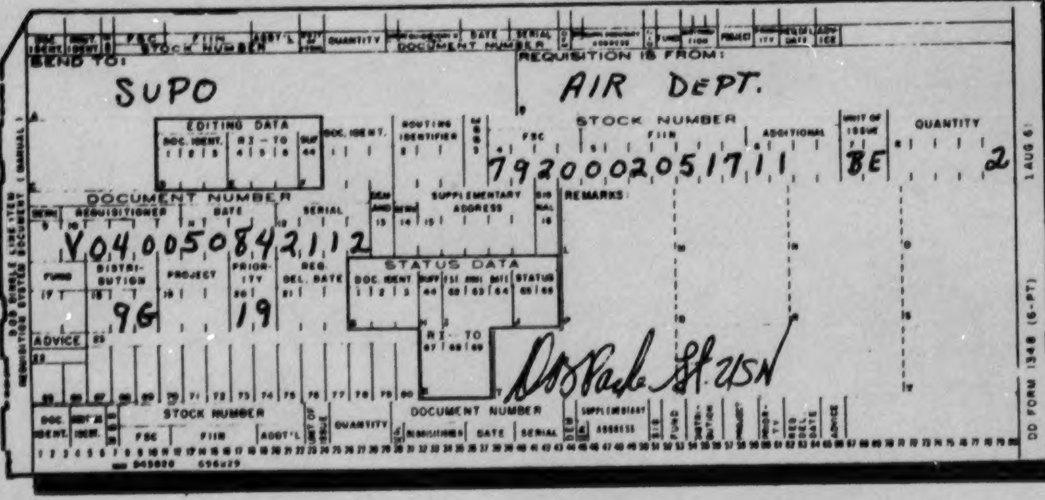
The ABF may encounter a variety of local requisitioning channels, all designed to satisfy material requirements. Procedures at the consumer level are somewhat flexible. Normally, the single line item requisition, DD Form 1348, is the form on which material is procured from the supply department. It is important that the correct stock number, manufacturer's part number, and nomenclature be included on all requests in order to expedite identification and issue. Incorrect or omitted information can only lead to confusion and delay in issue, or possibly the wrong part or material may be issued.

Afloat, the request document is presented to the aviation stores division for technical aeronautical material, or to the supply office for other than aeronautical material. While individual ships may employ different procedures, such as a credit card system, the DD Form 1348 (fig. 2-20) is normally the request document. When it is necessary for the ABF to draw parts or material from supply, he prepares a DD Form 1348 and presents it to the air officer or his authorized representative for signature. The DD Form 1348 is then presented to the supply department for processing and receipt of material.

Ashore, the requisition may be presented directly to a supply warehouse or to an established retail issue outlet. Procedures may differ between shore stations because of assigned levels of maintenance, geographical location of shops relative to supply facilities, and other factors. Normally, the DD Form 1348 is the proper request document which is prepared and submitted in accordance with local instructions.

ACCOUNTING

Although accounting is not too important to the ABF, it is important that he have an



DOD SINGLE LINE ITEM REQUISITION SYSTEM DOCUMENT (MANUAL)

SEND TO: SUPO

REQUISITION IS FROM: AIR DEPT.

EDITING DATA: DOC. IDENT. | RI – TO | SUF

DOC. IDENT.

ROUTING IDENTIFIER

STOCK NUMBER: FSC | FIIN | ADDITIONAL: 7920002051711

UNIT OF ISSUE: BE

QUANTITY: 2

DOCUMENT NUMBER: REQUISITIONER | DATE | SERIAL: V040050842112

DEMAND

SUPPLEMENTARY ADDRESS

SIGNAL

REMARKS:

FUND

DISTRIBUTION: 96

PROJECT

PRIORITY: 19

REQ. DEL. DATE

STATUS DATA: DOC. IDENT. | SUF | RI | STATUS

RI – TO

ADVICE

D. D. Vade Lt. USN

DOC. IDENT. | STOCK NUMBER: FSC | FIIN | ADD'L | UNIT OF ISSUE | QUANTITY | DOCUMENT NUMBER: REQUISITIONER | DATE | SERIAL | SUPPLEMENTARY ADDRESS | FUND | DISTRIBUTION | PROJECT | PRIORITY | REQ. DEL. DATE | ADVICE

DD FORM 1348 (6-PT) 1 AUG 61

195.29.1

Figure 2-20.—Single line item requisition system document DD Form 1348.

understanding of the way in which it affects him.

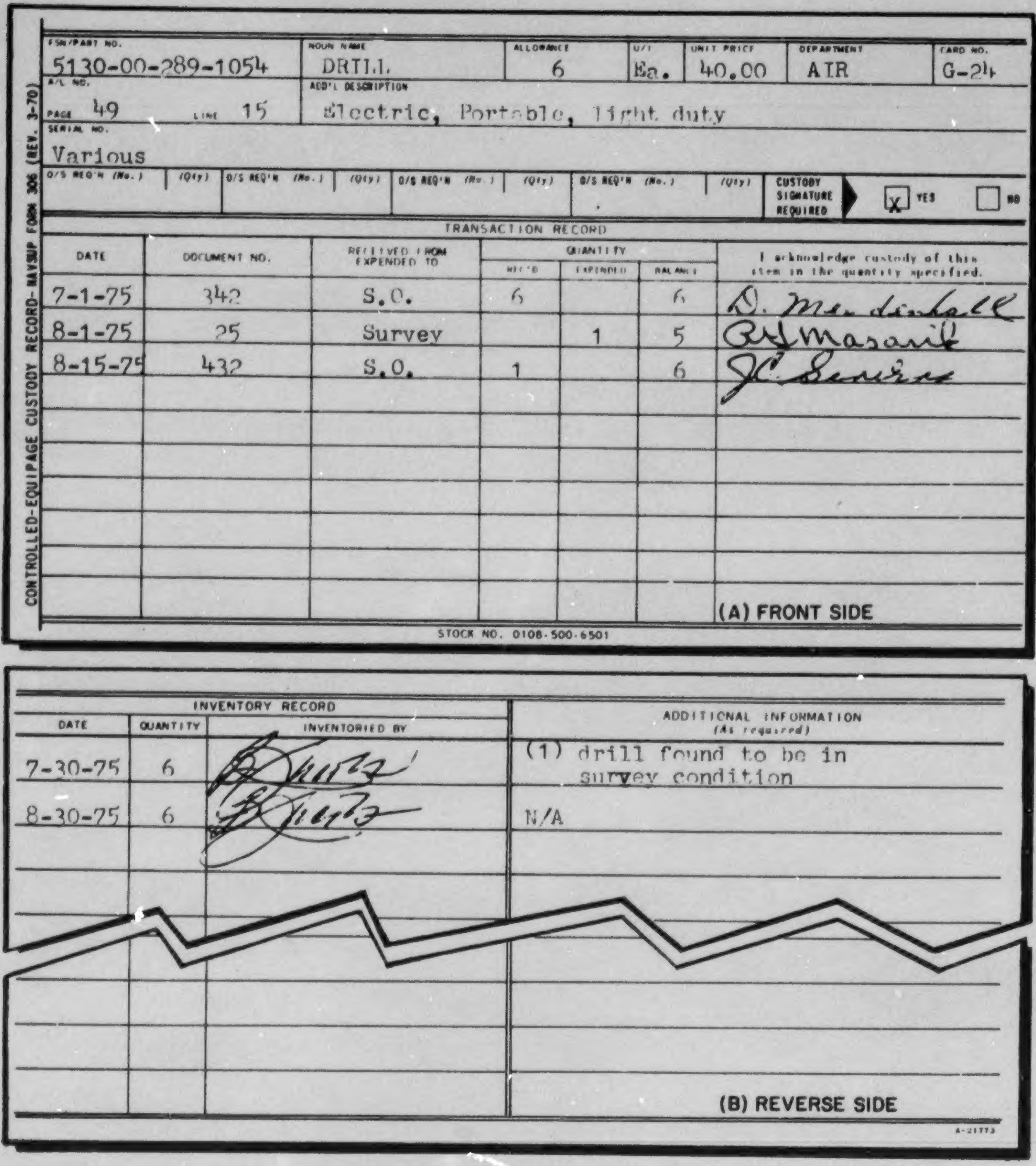
Every item used in the Navy must be paid for by money appropriated for the systems command supporting the using activity or the equipment on which the item is used. Some of the material can be used in many different applications, and until it is actually used no one knows who should charged. In order that the manufacturers may be paid promptly, this category of material is paid for from the Naval Stock Fund, and is carried in the Naval Stock Account. This is NSA material. When the issue is made, the cost is charged to the proper appropriation, and the money returned to the Naval Stock Fund. At the local level, the cost is charged to the air department's share of the ship's operating funds.

Some material used by the Navy can be used only in particular applications, and the purchasing officer knows exactly how it will be used and who will pay for it. The cost of this material is charged to the applicable appropriation when it is purchased, and the material is known as APA (Appropriation Purchases Account) material. There is no charge against local funds for APA material.

PROPERTY ACCOUNTING

Equipage is the term normally used to identify nonexpendable material for which custodial responsibility is designated by means of custody cards. An inventory count of equipage on hand must be brought into agreement with the amount shown on the custody cards. Any items missing at inventory, or found to be unserviceable, must be surveyed and expended from the custody record cards. (See figures 2-21(A)(B), and 2-22.) Equipage, on which custody cards must be maintained, is defined as those items having an accountability code designation of D, E, R, or L. Code D and E items are maintained on a custodial signature basis. Code R and L items, depending on the use of the item, are in some cases maintained on a custodial basis. All of these four coded items are normally exchanged on an item-for-item basis. There are two designations of custody record cards, NAVSUP Form 306 or 460.

Equipage is issued by the supply officer to the head of the applicable using department. The department is held accountable to the commanding officer for this material. It is apparent that the head of a department cannot personally keep track of all equipage for which



CONTROLLED-EQUIPAGE CUSTODY RECORD-NAVSUP FORM 306 (REV. 3-70)

FSN/PART NO. 5130-00-289-1054	NOUN NAME DRILL	ALLOWANCE 6	U/I Ea.	UNIT PRICE 40.00	DEPARTMENT AIR	CARD NO. G-24

A/L NO. PAGE 49 LINE 15

ADD'L DESCRIPTION Electric, Portable, light duty

SERIAL NO. Various

O/S REQ'N (No.) (Qty) O/S REQ'N (No.) (Qty) O/S REQ'N (No.) (Qty) O/S REQ'N (No.) (Qty)

CUSTODY SIGNATURE REQUIRED ☒ YES ☐ NO

TRANSACTION RECORD

DATE	DOCUMENT NO.	RECEIVED FROM EXPENDED TO	QUANTITY REC'D	QUANTITY EXPENDED	QUANTITY BALANCE	I acknowledge custody of this item in the quantity specified.
7-1-75	342	S.O.	6		6	D. Mendenhall
8-1-75	25	Survey		1	5	RJ Masarik
8-15-75	432	S.O.	1		6	JC Seniros

(A) FRONT SIDE

STOCK NO. 0108-500-6501

INVENTORY RECORD

DATE	QUANTITY	INVENTORIED BY
7-30-75	6	B Kurtz
8-30-75	6	B Kurtz

ADDITIONAL INFORMATION (As required)

(1) drill found to be in survey condition

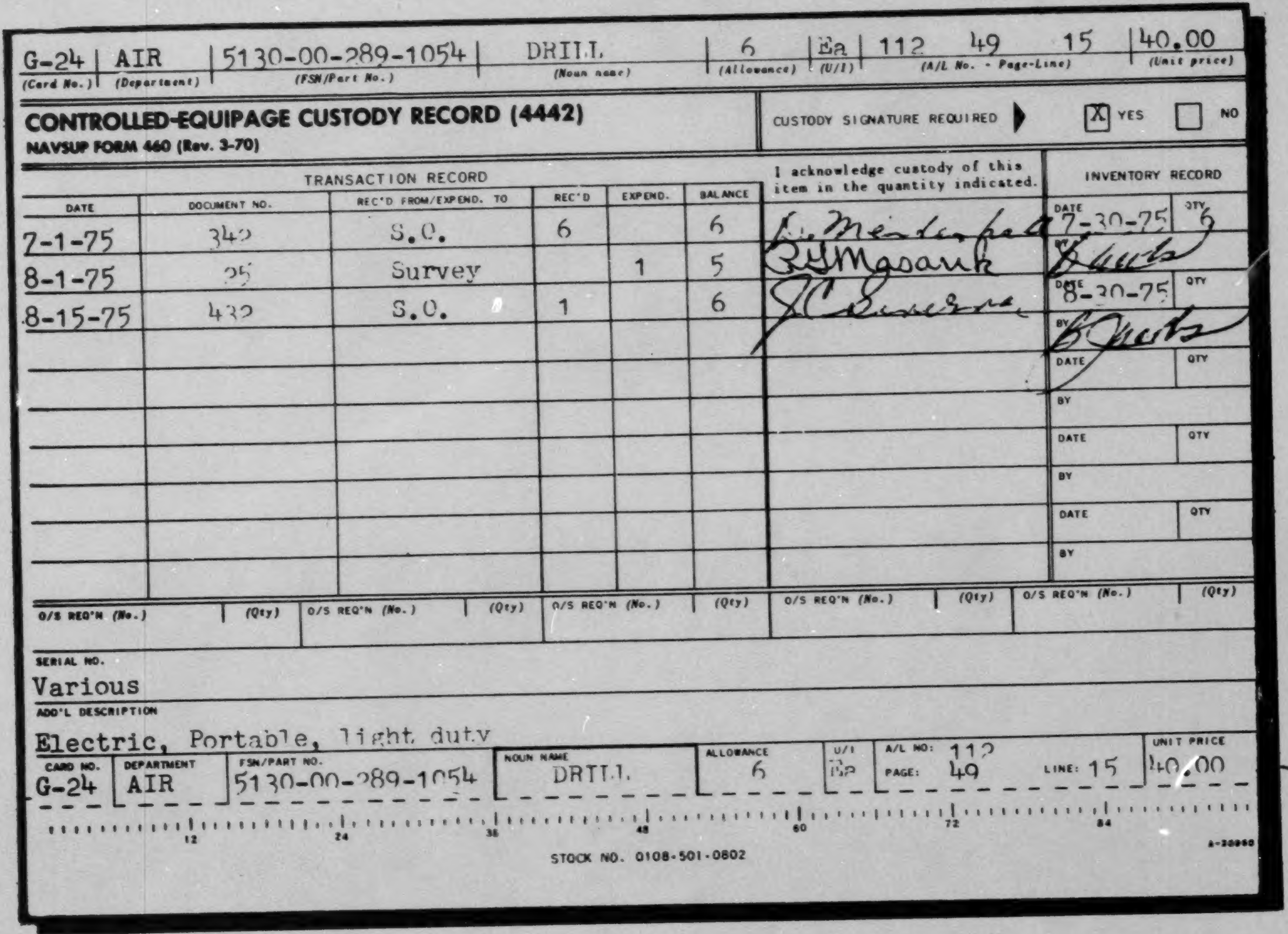
N/A

(B) REVERSE SIDE

A-21773

197.88

Figure 2-21.—Controlled Custody Record Card (NAVSUP Form 306).



G-24 (Card No.)	AIR (Department)	5130-00-289-1054 (FSN/Part No.)	DRILL (Noun name)	6 (Allowance)	Ea (U/I)	112 49 15 (A/L No. - Page-Line)	40.00 (Unit price)

CONTROLLED-EQUIPAGE CUSTODY RECORD (4442)
NAVSUP FORM 460 (Rev. 3-70)

CUSTODY SIGNATURE REQUIRED ▶ ☒ YES ☐ NO

TRANSACTION RECORD

DATE	DOCUMENT NO.	REC'D FROM/EXPEND. TO	REC'D	EXPEND.	BALANCE	I acknowledge custody of this item in the quantity indicated.
7-1-75	342	S.O.	6		6	
8-1-75	25	Survey		1	5	
8-15-75	432	S.O.	1		6	

INVENTORY RECORD

DATE	QTY
7-30-75	6
BY	
8-30-75	
BY	
DATE	QTY
BY	
DATE	QTY
BY	
DATE	QTY
BY	

O/S REQ'N (No.)	(Qty)	O/S REQ'N (No.)	(Qty)	O/S REQ'N (No.)	(Qty)	O/S REQ'N (No.)	(Qty)	O/S REQ'N (No.)	(Qty)

SERIAL NO.
Various

ADD'L DESCRIPTION
Electric, Portable, light duty

CARD NO.	DEPARTMENT	FSN/PART NO.	NOUN NAME	ALLOWANCE	U/I	A/L NO:	PAGE:	LINE:	UNIT PRICE
G-24	AIR	5130-00-289-1054	DRILL	6	Ea	112	49	15	40.00

12 24 36 48 60 72 84

STOCK NO. 0108-501-0802

197.89

Figure 2-22.—Controlled Equipage Custody Record Card (NAVSUP Form 460).

he is held accountable. Therefore, he must delegate custodial responsibility to the division officers and/or leading petty officers using or having the material in their custody. When an ABF is assigned custodial responsibility, he is required to sign a memorandum receipt to his division officer or department head for the material for which he is responsible.

The ABF is responsible for knowing the location of and maintaining equipage placed in his custody by his department head or division officer.

Inventory of equipage is held whenever a ship is commissioned or decommissioned, or whenever the commanding officer requires it. The supply officer coordinates and sets up the inventory with the approval of the commanding officer. Each department is advised of the inventory in writing by the supply officer. It is the responsibility of each department head to inventory the equipage assigned to his department. ABFs are normally required to physically inventory all equipage assigned to them on a custody receipt from the air officer or their division officer.

The inventory count of equipage on hand must be brought into agreement with the amount shown on the custody cards. Any items missing at inventory, or found to be unserviceable, must be surveyed and expended from the custody record cards.

Inventory is normally conducted by teams of two men. One carries the custody record cards and records the inventory count on the cards while the other conducts the physical count. After the count is completed and recorded, discrepancies are corrected and cards reconciled with the master custody record cards held by the supply officer.

Periodic inventories or spot checks may be required by the department head or division officer to ensure that material is on hand and in a serviceable condition.

STOWAGE

Proper stowage of his material and equipment is vitally important to the ABF. Everything movable which is not in use should be kept in bins or racks or lashed securely into place. Sudden hard turns, rough weather, or vibration at high speeds can tumble material or throw it across a compartment, ruining equipment and possibly causing serious personnel injuries. There is not always time to secure loose gear before a sudden turn.

Material and equipment should be stowed as near as possible to the place where it will be used. Careful planning will allow use of space which otherwise might be wasted because of its size, shape, or accessibility. If the items to be stowed are pilferable, locks should be placed on the access doors or on the racks holding the material in place. Emergency equipment should not be locked up.

CHAPTER 3

CHARACTERISTICS AND PROPERTIES OF AVIATION FUELS

CHARACTERISTICS OF AVIATION FUELS

Aircraft fuels in use at naval air activities may be divided into aviation gasoline and jet engine fuels. A knowledge of the important basic characteristics of these fuels is necessary in understanding the importance of delivering the proper fuel to the aircraft. Such knowledge is also valuable in understanding the need for safety and caution in handling these fuels. This chapter includes the basic characteristics of aviation gasolines and jet engine fuels which fuel handling personnel should know.

Aviation gasolines and jet engine fuels are petroleum products manufactured from crude oil by oil refineries. Both are classified as flammable liquids. This means that they will burn when ignited. Under proper conditions they will explode with forces similar to those of TNT or dynamite. Death can result if the vapors of either type fuel are inhaled in sufficient quantities, and serious skin irritation can result from contact with the fuels in the liquid state. In the liquid form aircraft fuels are lighter than water, and in the vapor form they are heavier than air. Consequently, any water present in the fuels will usually settle to the bottom of the container. On the other hand, vapors of these fuels, when released in the air, tend to remain close to the ground, thus increasing the danger to personnel and property. From safety and health standpoints, both aviation gasolines and jet engine fuels must be handled with caution.

Although JP-5 does have a high flashpoint (140°F minimum) when manufactured, it readily dissolves aviation gasoline vapors and liquid to become unsafe. On rags or waste it is very flammable.

Aviation gasolines are used for reciprocating (piston type) engines similar in principle to automobile engines. Jet engine fuels, on the other hand, are intended for use in an entirely different type engine. The jet engine has no pistons but, instead, has an air compressor or compressors, a combustion section, and a turbine or turbines. Since these are completely different engines, they require different fuels. A high performance reciprocating aircraft engine will not operate with jet engine fuel or a low octane number gasoline, and a jet engine designed for standard jet engine fuel will not usually operate properly with aviation gasoline. In understanding the reasons why these two types of engines require different types of fuels, it is necessary to know two important differences in the fuels required. These differences are discussed under "Volatility" and "Knock Value of Aviation Fuels."

FUEL, A SOURCE OF ENERGY

Aviation fuel is a liquid containing heat energy which can be turned into mechanical energy in the engine. This mechanical energy is then used to produce thrust which propels the aircraft. This basic requirement is, however, qualified by a number of other requirements which are almost as basic, since many liquids containing heat energy cannot be burned to produce mechanical energy in aircraft engines of current type. This discussion deals mostly with fuels for spark ignition engines of current type. In this discussion the term reciprocating engine is used to designate the spark ignition piston type engine burning gasoline which is currently used in some aircraft and almost all automobiles.

A discussion of fuels for aircraft jet engines (jet and propeller turbine) is also included.

An engine fuel must be made to suit the engines in which it is to be used. In the case of the aircraft engine, the fuel must also be suitable for the aircraft under a wide variety of operating conditions. There is no such thing as a universal fuel since a fuel which is suitable for a combat reciprocating aircraft engine will not work in a diesel engine and vice versa. Diesel fuel, in most cases, is not a satisfactory fuel for an aircraft gas turbine.

While the fuel must be suitable for the engine, the engine must also be suitable for the fuel. Making the engine suitable for the fuel is necessary to ensure that adequate supplies are available for the intended use.

GRADES OF AVIATION GASOLINES

Reciprocating engine fuels for aircraft (AvGas) are presently classified into types and grades in the following manner:

NATO Symbol	U.S. Military Grades	U.S. Commercial Grades	Color
F-12	80/87	80/87	Red
F-18	100/130	100/130	Green
F-22	115/145	115/145	Purple

The commercial grades of AvGas are approved for use in Navy aircraft. The commercial grades of AvGas may have approximately the same octane or performance number but differ in chemical composition. For example, the commercial specifications allow less tetraethyl-lead to be added to the fuel to produce the required octane or performance number.

These grade designations are relative measurements of the tendency of the gasoline to knock when used in spark ignition reciprocating engines. Grade designation of 100 and lower are octane numbers; while those above 100 are performance numbers. The first number indicates the knock rating with a lean fuel-air mixture, and the second indicates the knock rating with a rich fuel-air mixture.

GRADES OF JET ENGINE FUELS

Turbine engine fuels for aircraft (jet fuel (JP)) are presently classified into types and grades in the following manner:

NATO Symbol	U.S. Military Grades	U.S. Commercial Grades	United Kingdom Grades
F-34	None	Jet A-1	AVTUR/50
F-40	JP-4	Jet B	AVTAG
F-42	None	None	AVCAT/40
F-44	JP-5	None	AVCAT/48

AVTUR/50 is sometimes designated overseas as JP-1B. Jet B is equivalent to JP-4 in all respects, except that the freezing point is -60°F instead of -72°F.

Fuels having the same NATO symbols are interchangeable. Detailed information on the interchangeability of NATO aviation fuels and lubricants, together with the related specifications of the NATO Nations, is contained in NAVSEA Instructions 10300 (Series). NATO code numbers and aircraft marking symbols are shown in table 3-1.

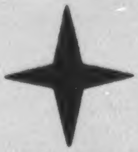
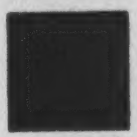
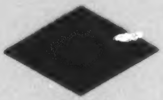
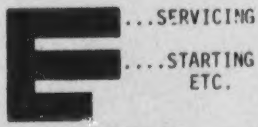
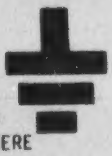
The U.S. Military grades of jet engine fuels are designated by the letters JP followed by a numeral. Unlike aviation gasoline, the grade designations for jet engine fuels have no significance as far as the octane number or other performance characteristics of these fuels are concerned. The numeral merely indicates the approximate numerical sequence in which the fuel specifications were accepted by the military organization.

VOLATILITY

The volatility of a petroleum fuel is usually measured in terms of vapor pressure and distillation. The vapor pressure indicates the tendency toward vaporization at specific temperatures, while distillation provides a measure of the extent to which vaporization will proceed at a series of temperatures.

Table 3-1.—NATO code numbers and symbols

NATO CODE NUMBERS AND SYMBOLS

General type of product	NATO code number	AIRCRAFT MARKINGS		
Piston engine fuels:		Purpose	Description	Symbol
Leaded aviation gasoline-grade 80/87	F-12	REFUELING	FILLED FOUR POINTED STAR WITH NOTATION OF NATO CODE NUMBER FOR FUEL AND MAXIMUM FILLING PRESSURE IN ENGLISH AND METRIC SYSTEMS	 NATO CODE NO. MAX FILLING PRESSURE ___PSI ___Kg/Cm^2
Aviation gasoline-grade 100/130	F-18			
Aviation gasoline-grade 115/145	F-22			
Turbine engine fuels:		ENGINE LUBRICATING OIL	FILLED SQUARE WITH NOTATION OF NATO CODE NUMBER FOR ENGINE LUBRICATING OIL AND MAXIMUM FILLING PRESSURE IN ENGLISH AND METRIC SYSTEMS	 NATO CODE NO. MAX FILLING PRESSURE ___PSI ___Kg/Cm^2
Wide cut gasoline type (U.S. JP-4)	F-40			
High flash kerosene type (U.S. JP-5)	F-44			
Piston engine oils:				
Grade 1100	0-117	FIRE EXTINGUISHING SYSTEM	A FILLED DIAMOND WITH NOTATION SHOWING NATO CODE NUMBER	 NATO CODE NO.
rade 1065	0-113			
Turbine engine oils:				
Grade 1010	0-133			
Grade 1005	0-132	EXTERNAL ELECTRICAL CONNECTIONS	A FILLED VERTICAL BAR WITH THREE EQUALLY SPACED HORIZONTAL BARS ON RIGHT HAND SIDE WITH NOTATIONS TO INDICATE CHARACTERISTICS AND PURPOSE	 28V OR 115 V DC 115/200V, 400 CYCLES
Synthetic type 3 cst viscosity	0-148			
Synthetic type 5 cst viscosity	0-156			
		GROUNDING OR EARTHING RECEPTACLE	A FILLED INVERTED "T" WITH TWO PARALLEL BARS UNDERNEATH WHICH DIMINISH IN SIZE	 GROUND (EARTH) HERE

197.90

Vapor pressure is measured in a Reid Vapor Pressure Test Bomb. In the test, one volume of fuel and four volumes of air are contained in a sealed bomb fitted with a pressure gage. The container and fuel are heated to 100°F, shaken and the pressure read on the gage. The pressure shown on the gage is known as the Reid Vapor Pressure (RVP) and is expressed in pounds per square inch (psi).

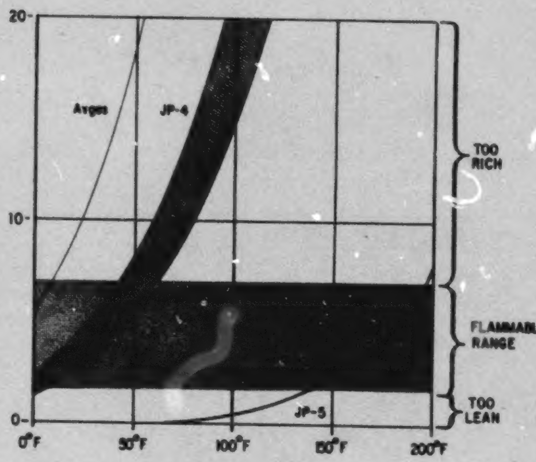
The measurement for volatility by distillation is done in a standard distillation apparatus. The fuel in this test is heated to given temperatures, and the amount of fuel boiled off at each temperature is measured. The Military Specification for the fuel will give these temperatures and the percentages of the fuel allowed to boil off to meet the desired standard.

Any fuel must vaporize and the vapor be mixed in a given percentage of air for it to burn or explode. For gasoline vapors in air, the limits are approximately a minimum of 1 percent and a maximum of 6 percent by volume. Other types of fuel vapors may have different limits.

Volatility is a very important factor in the proper operation of reciprocating engines. In a reciprocating engine the fuel must vaporize and be mixed with a correct volume of air in order to burn and deliver power. If part of the fuel does not vaporize, it is wasted and, furthermore, can damage the engine by washing the lubricant from the engine cylinder walls, causing rapid wear to the piston rings and cylinder walls.

Military grades of aviation gasoline must have a minimum of 5 1/2 psi and a maximum of 7 psi vapor pressure. The minimum pressure is specified to control starting, warm up, and the atmosphere above the fuel in the aircraft fuel tanks. The maximum is specified to prevent too great a loss of fuel at high altitudes and vapor lock during rapid climbs.

Military jet fuels in use at the present time by the Navy include JP-4 which has a vapor pressure of 2 to 3 psi, and JP-5 which has no specification for vapor pressure. The vapor pressure for JP-5 is almost 0 psi at normal room temperatures and at standard atmospheric pressure.



197.8

Figure 3-1.—Vaporization of aviation fuels at atmospheric pressure.

AvGas has a very strong tendency to vaporize and, as a result, will always have considerable vapors mixed with the air over the surface of the liquid. In fact, in a closed tank at sea level with temperatures approximately 10°F or higher, so much fuel vapor is given off by AvGas that the fuel-air mixture is too rich to burn. When fuel is in contact with air, the fuel continues to evaporate until the air is saturated. The variation of the saturation value with temperature is shown for three aircraft fuels in figure 3-1.

The amount of fuel vapor in the air above a fuel can never be greater than the saturation value. Of course, it takes time to saturate the air with fuel vapor, so the actual percentage of fuel vapor may be considerably below the saturation point—especially if the fuel container is open to air circulation.

Only fuel-air mixtures within the flammable range shown in figure 3-1 will burn. The flammable range for all present-day aircraft fuels is approximately 1 1/2 to 7 percent. It is obvious from figure 3-1 that JP-5 fuel does not give off enough vapor to be explosive until it is heated considerably above 100°F. However, if the JP-5 fuel is contaminated with even a small amount of AvGas, the amount of vapor given off increases to the point where it will be in the flammable range at a much lower temperature. At room temperature, 0.1 percent AvGas or

JP-4 in JP-5 results in a fuel that is unsafe to store aboard ship since it fails the flashpoint requirement for unprotected storage.

Grade JP-4, because of the range of its vapor pressure, forms explosive vapors from minus 10°F to plus 80°F, its normal storage and handling temperatures. This means that the space above the liquid almost always contains an explosive mixture.

SOLVENCY OF AVIATION FUELS

All aviation gasolines have the characteristic of being able to dissolve a number of materials. They will dissolve common lubricants, such as oils and greases in pumps, valves, packing, and other equipment. This characteristic requires the use of special lubricants for aviation gasoline services. Aviation gasolines will also cause serious deterioration of all rubber materials except those synthetic types designed especially for gasoline service. It is very important, therefore, that only hose specially made and designated for aviation gasoline be used in this service. This also applies to packing, gaskets, and other materials which must be used in aviation gasoline systems.

Like aviation gasoline, jet engine fuels have certain solvent properties which dissolve greases and cause deterioration of some rubber materials. Therefore, only specially designated greases and synthetic materials should be used for jet engine fuel service. Another important solvent property of jet engine fuels is their ability to dissolve asphalt, which is used for aircraft runways and pavements. Jet engine fuels will seriously damage asphalt pavements, and spills of this fuel on asphalt pavement should be avoided.

FREEZING POINTS OF AVIATION FUELS

The freezing point of a fuel is the temperature at which solid particles begin to form in the fuel. These particles are waxy crystals which are normally held in solution in the fuel. These particles can readily block the filters in an aircraft fuel system. The fuel almost always becomes cloudy before the solid particles form. This cloud is due to the presence of dissolved water in the fuel coming out of solution and freezing.

Table 3-2.—Flash and freezing point of aviation fuel

NATO Symbol	Flash-point	Freeze Point	Characteristics
F-22	- - -	-76°F	115/145 AvGas.
F-34	100°F	-58°F	Kerosene type, low freeze point.
F-40	- - -	-72°F	Wide cut gasoline type.
F-42	140°F	-40°F	High flashpoint kerosene type, high freeze point
F-44	140°F	-51°F	High flashpoint kerosene type, low freeze point.

All current aviation fuel used by the U.S. Navy has a freezing point considerably below -76° with the exception of JP-5. The freezing point ofJP-5 is -51°F. The fuels used by other NATO countries and by commercial users vary widely. See table 3-2 for the freezing points of some of these fuels.

FLASHPOINTS OF AVIATION FUELS

The flashpoint of aviation fuels is the lowest temperature at which the fuel will vaporize enough to form a combustible vapor. These temperatures vary according to the fuel in question. See table 3-3 for an example of some of these differences.

The flashpoint of a fuel is an index of the fuel's potential safety in handling and storage. The F-42 and F-44 (JP-5) fuels must have a flashpoint of at least 140°F in order that they

Table 3-3.—Fuels comparison chart

Fuel	Use	Color	Weight in lb/gal at 60° F	Maximum vapor pressure	Maximum freezing point	Flash-point	Lead content ml/U.S. gal (max)
80/87	Motor vehicles; trainer aircraft	Red	5.96	7 psi	-76°F	**- - -	0.5
100/130	Transport aircraft	Green	5.98	7 psi	-76°F	**- - -	4.6
115/145	Combat aircraft	Purple	6.00	7 psi	-76°F	**- - -	4.6
JP-4	Jet aircraft	Straw to water-white	6.675	3 psi	-72°F	**- - -	None
JP-5	Jet aircraft	Straw to water-white	*6.563 to 7.034	**- - -	-51°F	Minimum 140° F	None

* Depends on specific gravity.
** No Military Specifications requirement.

will have the high safety factor required for storage aboard an aircraft carrier in unprotected tanks. F-40 (JP-4) and F-22 (AvGas) fuels will flash at any normal temperature and are in danger of ignition any time they come in contact with a hot surface. Therefore, these fuels must be handled with caution from a safety standpoint.

HEALTH HAZARDS OF AVIATION FUELS

Most people are aware of the explosive and fire potential of aviation fuels. Furthermore, there is a great danger to the health of the individual who must work where hydrocarbon vapors are present. Prolonged inhalation of hydrocarbon vapors can cause dizziness, intoxication, nausea, and death. Residues of AvGas may be very poisonous since they normally contain lead. Consequently, approved safety procedures that minimize the dangers to the health of fuel handling personnel must be followed meticulously.

Gasoline

The concentration of gasoline vapors which can be tolerated by man is far below that required to produce combustible or explosive mixtures with air. Even one-tenth of the amount necessary to support combustion or to form an explosive mixture is harmful if inhaled for more than a short time, causing dizziness, nausea, and headache; large amounts act as an anesthetic causing unconsciousness or death.

Men should not be permitted to work in spaces where hydrocarbon vapor concentrations exceed 500 parts per million by volume, unless they are protected by an air supplied respirator. It is recommended that men be permitted to work only in well-ventilated spaces where the hydrocarbon vapors are at or below the permissible limit.

The occurrence of any of the symptoms mentioned, among men who are handling gasoline or who are within an area in which gasoline is handled or spilled, should be taken as a warning of the presence of dangerous amounts of gasoline vapor in the air. All exposed personnel must be sent out of the area until the vapors have been cleared. Recovery from early symptoms is usually prompt after removal to fresh air. If men have been overcome, they should be given first aid at once. Medical attention should be obtained promptly. First aid consists of the removal of gasoline from the skin (if the skin or clothing has been contaminated in a fall or other accident), the prevention of chilling, and application of artificial respiration if breathing has ceased.

Aviation gasoline contains a larger amount of tetraethyllead than ordinary gasoline and, therefore, has a greater poisonous effect on the human system. Tetraethyllead, which has been added to increase the anti-knock value of gasoline, vaporizes and is present in slight amounts with the gasoline vapor. The lead compound may enter the body through inhalation, by absorption through the skin, and by the mouth. Also, the gasoline vapor itself when inhaled may result in sickness. Therefore:

1. Avoid contact with liquid gasoline.
2. Do not inhale gasoline vapors.
3. Do not enter tanks that have contained aviation gasoline until all traces of gasoline vapors have been eliminated and the hazard of lead poisoning has been reduced to a minimum.

NOTE: Sediment and sludge impregnated with gasoline and volative organic lead compounds may be present at the bottom of the tank, which constitutes a serious fire and poison hazard until the tank is thoroughly cleaned. Before entering the AvGas stowage tanks, permission must be obtained from the commanding officer, and the gas-free engineer must test and certify the tanks are "safe for entry."

The danger of entering a tank that has been used for the storage of gasoline may be very great, because of the chance of exposure to the toxic concentration of gasoline vapors as well as to dangerous quantities of lead vapors in the air and in the sludge, wet or dry, in the bottom of such tanks. No person should be permitted to enter such a tank without special equipment and complete instructions for its use.

Gasoline is exceedingly irritating when swallowed. If gasoline should be swallowed, accepted first aid procedures must be followed and medical attention must be obtained as soon as possible. Gasoline will cause severe burns if it is allowed to remain in contact with the skin, particularly when the contact is maintained under soaked clothing or gloves. Clothing or shoes through which gasoline has soaked should be removed at once. Repeated contact with gasoline removes the protective oils from the skin, producing drying, roughening, chapping, and cracking. Skin infection may follow this damage to the skin. A severe irritating of the skin may develop beginning usually on the hands and perhaps extending to other parts of the body. These effects upon the skin are generally due to the gasoline and not to the small amount of lead that has been put into lead-treated gasoline. However, continued exposure to leaded gasoline is very dangerous since lead is a cumulative poison and can be absorbed through the skin as well as by inhalation of vapors. As soon as possible after contact, the gasoline should be removed from the skin, preferably by washing with soap and water. Rags or waste, wet with gasoline must not be put in a pocket, but must be disposed of at once. Soaked clothing must be kept away from flame or sparks, and should be washed out thoroughly with soap and water as soon as possible. If gasoline comes in contact with the eyes, accepted first aid procedures for its removal must be followed.

Jet Fuels

Jet fuels do not contain tetraethyllead. However, they may contain more toxic aromatics than aviation gasolines. They should, therefore, be handled with the same health precautions as apply to leaded gasolines. They should not be used for cleaning purposes. The hygienic or health aspects for aviation gasoline, therefore, apply equally as well to jet fuels. This includes precautions covering particularly inhalation of vapors, skin irritations, and container hazards.

The Standard First Aid Training Course, NAVPERS 10081-A, should be studied by all personnel working with aviation fuels for information on the treatment of those overcome or injured due to the handling of fuels.

WATER CONTENT IN AVIATION FUEL

Water may be present in aviation fuels in three different forms; dissolved, entrained, and free water.

Dissolved Water

All fuels contain water in solution but the amount varies considerably as the temperature of the fuel varies. The colder the fuel the less water it can hold in solution. This water cannot be separated from the fuel by filtration or by mechanical means. The percentage of dissolved water, which can only be determined by a laboratory test, is usually expressed as PPM (parts per million).

Free Water

All water present in the fuel which has not been dissolved by the fuel is considered free water. This water can be removed from the fuel by settling and/or filtering.

Entrained Water

Free water which is suspended throughout a fuel sample and has not settled to the bottom of the container is considered entrained water.

All military gasoline specifications contain a requirement that the fuel neither gains nor loses in volume when shaken with water. This requirement is to prevent the addition of components which would separate on contact with water (as do wood and grain alcohols) and to ensure that the fuel will not dissolve excessive quantities of water.

This provision in the specifications would be insufficient to prevent trouble in service were it not for the fact that the specifications also require that the fuel consists entirely of hydrocarbons except for specified contents of lead, sulfur, dye, bromine, inhibitors, and xylidine, or similar materials.

Some fuel compounds containing oxygen and having very excellent knock properties do not mix with water as do wood and grain alchohols; but when blended with gasoline, the blend will dissolve at summer temperatures several times as much water as do gasolines not containing such compounds. The dissolved water with such blends or with normal fuels is not harmful until the temperature of the fuel is reduced. However, when the temperature of the fuel is reduced, dissolved water immediately starts to be thrown out of solution. The water can accumulate and cause freezing and plugging of a fuel line.

The value of alcohols (wood, grain, and isopropyl) as deicing agents for carburetors, propellers, etc., is due to their ability to mix with water and form an antifreeze mixture that will dissolve ice.

Jet fuels must produce a sharp clean separation when mixed with water. Jet fuels do have a greater affinity for water than reciprocating engine fuels (gasoline). The settling of entrained water is also a great deal slower in jet fuels (especially JP-5) than in gasoline. The consumption rate of jet fuel per engine hour is much greater than the reciprocating engine, and the jet engine fuel controls are generally more susceptible to malfunction due to icing in the fuel than in a reciprocating engine carburetor.

The anti-icing additive that is added to JP-4 and JP-5 is very soluble in water. For this reason care must be taken that these fuels are put only into tanks that are as free as possible from water.

SUMMARY OF CHARACTERISTICS OF AVIATION FUELS

In summary, it is important that fuel handling personnel remember the following characteristics of aviation fuels:

1. From the standpoint of fire, explosion, and health, aviation gasolines and JP-4 are extremely hazardous and must be handled with equal caution. JP-5 jet fuel is safer explosive-wise and in poisoning effect; however, the potential fire hazard from fuel-soaked rags and waste and skin blistering from soaked clothing must not be ignored.
2. Jet engine fuels and aviation gasolines are designed for entirely different types of engines; therefore, only the proper fuel must be used for each type aircraft.
3. Aviation gasolines and jet engine fuels are divided into a number of different grades, and the proper grade of fuel must be used for each aircraft.

PROPERTIES OF AVIATION FUELS

CHEMICAL COMPOSITION

It is hardly possible to enter into a discussion of aviation fuels without a brief mention of their chemical composition. The aviation fuels currently used consist almost entirely of hydrocarbons; namely compounds consisting only of hydrogen and carbon. In the case of average gasolines presently used by the military services, each 1,000 pounds of fuel will contain about 847 1/2 pounds of carbon, 150 pounds of hydrogen, and the remaining 2 1/2 pounds will consist of sulfur, lead, bromine, dye, and entrained water. Sulfur is present as an impurity, and the very small amount of entrained water cannot be avoided since the fuel is exposed to damp air. Lead and bromine are deliberately added for the purpose of reducing the tendency to knock, which is discussed below.

Jet fuels are also predominantly hydrocarbons with a little more carbon, somewhat less hydrogen, and may contain as much as 4 pounds of sulfur per 1,000 pounds of fuel.

Compounds containing only hydrogen and carbon release, when burned, the greatest amount of energy for a given weight of fuel. Thus, a fuel consisting only of hydrogen and carbon may produce 2 1/2 horsepower for 1 hour for each pound of fuel burned by a piston engine. Wood (methyl) alcohol, which contains about half oxygen by weight, has only about half as much energy per pound as the best hydrocarbons. Consequently, where 1 pound of hydrocarbon fuel will be required to produce 2 1/2 horsepower for 1 hour, it will require under the same conditions that about 2 pounds of wood alcohol be used. Similar limitations apply in the case of turbine fuels–1 gallon of kerosene will propel the aircraft as far as 2 gallons of wood alcohol.

Wood alcohol has the lowest available energy per pound of the various alcohols and other fuels containing oxygen, but all such compounds suffer from the same objection. Compounds containing oxygen obviously require that the aircraft carry a greater weight of fuel for a given mission. This disadvantage is sufficient to eliminate the use of such fuels. Fuels containing oxygen have some advantages, but these advantages do not overweigh the objections of low available energy.

Currently, jet engine fuels are solely straight hydrocarbon fractions. JP-4 is used primarily on naval air stations and by the U.S. Air Force. JP-5 is a less volatile jet fuel that is now the Navy's primary jet fuel. It is safer to store, more thermally stable, and has higher heat content per gallon than JP-4.

JP-5 is a kerosene-type fuel with a vapor pressure close to 0 psi. Since it has a lower tendency to vaporize than the more volatile grades, the vapor-air mixture in tanks or containers above its liquid surfaces will generally be too lean to be ignited until the surface of the liquid reaches a temperature of about 140°F. JP-5 is used by all shipboard jet-type Navy aircraft. It is also available on most shore stations.

KNOCK VALUE OF AVIATION FUELS

The major factor limiting the compression ratio of a spark ignition reciprocating engine is detonation (knock). Compression ratio is one of the determining factors in the amount of power that can be produced by an engine of a given size. The higher the compression ratio, the greater is the power produced. In turn, the higher the compression ratio, the higher must be the anti-knock qualities of the fuel.

Under certain conditions the fuel charge in an engine cylinder may autoignite (spontaneously before a spark is produced by the spark plug) and burn almost instantaneously. This instantaneous burning produces an audible knock. Instantaneous burning can cause severe damage to the engine in a very short time, and sustained detonation cannot be tolerated because it will cause engine failure.

In an automobile engine this knock can normally be heard and the knocking stopped by backing off the throttle (accelerator) and reducing the load on the engine. In an aircraft engine this knocking cannot be heard due to the other noises that drown it out. For this reason conditions that will produce knocking in an aircraft reciprocating engine must be strictly avoided.

Because of the importance of the knock value of fuels, tests have been devised by which this quality of gasolines can be determined. These tests, made with standard test engines and methods, measure the relative knock value of gasolines by octane numbers or performance numbers. For designating relative knock values of 100 and below, octane numbers are used; and for values above 100, performance numbers are used. The higher the octane number of the fuel, the less is the tendency of the fuel to knock. Some aircraft engines are designed to operate on lower octane number aviation gasolines, while others require gasolines with the highest performance numbers. The required octane number or performance number of the fuel is known for each type aircraft engine used by the Navy. It is very important that gasoline with the proper octane or performance number be delivered to the aircraft. Another important fact to remember is that very small quantities of jet engine fuel, when mixed with aviation gasoline, will lower the knock value of the gasoline.

The turbine (jet) engine is not subject to detonation due to the design and operation of the engine. Therefore, the specifications for jet fuels have no knock requirements. Due to other requirements the antiknocking qualities of jet fuels are very low and, consequently, must never be used in a spark ignition reciprocating engine. The characteristics of JP-5, which are similar to diesel fuels, allow it to be used in some diesel engines.

NAVAIR Instruction 10341.1 (Series) gives precise instructions on the proper utilization of aviation fuels in the Navy.

TETRAETHYL LEAD (TEL)

Grade 80/87 represents the highest grade of gasoline used by military services which can be made from crude oil by a simple distillation process. To produce grades above 91/96 (this grade is no longer used by the military services), an elaborate chemical process, plus the addition of tetraethyl lead, is required.

Lead is used in relatively small quantities in aviation gasoline, and for military service has never been used to an extent greater than one volume of lead to 630 volumes of gasoline. The standard method in this country of expressing lead quantity or concentration is in terms of milliliters (a milliliter has the volume of a cube with sides having a length of one centimeter of approximately three-eighths of an inch—a milliliter is hereafter abbreviated to ml) per United States gallon (a U.S. gallon contains 3,785 ml). The maximum lead concentration of one part to 630 parts of gasoline corresponds to 6 ml per U.S. gallon. At the present time the largest amount of lead allowed in a gallon of military aviation gasoline is 4.6 ml.

In speaking of lead concentrations, it is usual to refer to milliliters alone without mention of U.S. gallon (in other countries other standards are used). Lead, if added alone to gasoline, would burn to lead oxide, which is a solid with a very high boiling point and most of which would remain in the cylinders. To prevent this, a gasoline-soluble bromide compound is added to the lead, and this produces lead bromide on combustion. Lead bromide has a much lower boiling point than lead oxide and in consequence most of the lead bromide is expelled from the cylinder with the exhaust gas.

The lead compounds in the basic fuel, fuel vapors, and combustion deposits are very toxic and present a definite health hazard.

PURPOSE OF DYE

Dye was first added to gasoline in a mixture of lead and bromine (known as antiknock compound) to indicate that the gasoline should not be used for cleaning, cooking, etc. It was later added to motor gasoline which did not contain lead as a means of avoiding the expensive and useless bleaching to water-white color, which color the public had come to associate with good gasoline.

In aviation, gasoline dye is added for the following reasons:

1. To indicate that it should not be used for cleaning or for cooking (except in special military cook stoves suitable for such use).
2. If it is red and is known to be aviation gasoline, it is grade 80. The fact that it is red, however, does not indicate that it is aviation gasoline. It may be all-purpose 80 octane number automotive (combat) gasoline, or may be civilian motor gasoline.
3. If green, it is grade 100/130.
4. If purple, it is grade 115/145.

Unlike aviation gasolines, no dyes are added to jet engine fuels to aid in their identification. Instead, they are natural color as received from the refineries. This color may vary from water-white to a light straw color.

NOTE: The Navy uses a highly concentrated red dye for the detection of fuel leaks in aircraft fuel systems, regardless of the type of fuel, AvGas or JP-5. (This would be the only time that color is ever added to JP-5). This red color should not be taken as the grade of fuel and should be disregarded when taking fuel samples.

A notation must be made in the Aircraft Logbook if the red dye has been used. Fueling crews should check the logbook before defueling aircraft, as this fuel must NOT be returned to the bulk stowage tanks.

SUMMARY OF PROPERTIES OF AVIATION FUELS

Aviation fuels contain mostly carbon and hydrogen. The arrangement and amount of each determine the grade and type of fuel–AvGas or JP type. It is very important that the proper grade and type be delivered to each aircraft. Color is one of the easiest methods of identifying the proper grade or type of AvGas.

AvGas does contain tetraethyl lead. Extreme caution must be exercised in handling AvGas because of the toxic hazard of the tetraethyl lead. JP-4 and JP-5 contain no tetraethyl lead.

A fuels comparison chart is included as table 3-3.

CHAPTER 4

AVIATION FUELS CONTAMINATION

One of the major objectives of fuel handling personnel is to deliver clean, water-free, and correct fuel to the aircraft. The fuel systems of modern aircraft are very complex, and they will not function properly if the fuel is contaminated with dirt, rust, water, or other foreign matter. Even very small quantities of dirt or solid matter can plug or restrict fuel metering orifices and accelerate the clogging of fuel filters. Very small quantities of water are also harmful since ice may be formed which could affect orifices, controls, and filters in a manner similar to dirt. The complete stoppage of fuel flow by ice or dirt causes engine failure, and partial stoppage may cause poor engine performance.

Aircraft engine failure or poor performance may also be caused by incorrect fuel or by contamination of the proper fuel with other petroleum products. A very small amount of jet engine fuel can contaminate aviation gasoline by reducing the anti-knock quality to such an extent that engine performance is seriously affected. Similarly, lubricating oils and hydraulic fluids are extremely harmful to the quality of aviation gasoline.

RESULTS OF FUEL CONTAMINATION

Contaminated fuel has been the cause of some aircraft accidents with a tragic loss of life, the loss of valuable aircraft, and at times, the grounding of entire squadrons. This means that clean fuel is a life-or-death matter with aviation personnel. The lesson has been learned by too many of our personnel the hard way, with fatal results. The time to become fuel conscious is now.

ENGINE FAILURES

Besides being deadly, contamination can be sneaky. A certain type of emulsion resulting from the presence of water and rust particles can adhere to the sides of an aircraft's fuel cells in such a manner that just draining out a sample of fuel will not necessarily show this deposit. It will continue to build up; perhaps part of it will wash off and pass through a strainer into a carburetor or fuel control. There can be only one result—reduced power and finally engine failure.

Foreign particles so small that they cannot be seen with the naked eye can cause damage in jet engines. The fuel control of a jet engine is a masterpiece of engineering and craftsmanship. It automatically regulates fuel flow to compensate for changes in altitude and speed. It makes practicable the piloting by human beings of the incredibly powerful jet aircraft. But doing these things requires that the fuel control have precisely fitted meters and valves. The moving parts within some of these meters and valves have clearances of less than 0.0005 of an inch. Particles of foreign matter only slightly larger than this clearance can jam the valve or prevent it from seating properly. Particles slightly smaller can stick and build up, or wedge between the parts. Thus, we must remove these particles that we cannot see except with a microscope.

DELAYED FLIGHTS

In addition to causing engine failures, fuel contamination can mean serious delays in flight operations. Normal procedure requires that all aircraft fueled from a source where contamination is discovered must be checked, and in some cases drained and refueled, before flight operations can proceed.

When a fuel is found to be contaminated, the contamination must be tracked back to its source and the cause corrected. Until the cause of the contamination is found and corrected, the contaminated system cannot be used. The fuel system may be a mobile refueler, air station hydrant refueling system, or the entire fuels system of an aircraft carrier. Contaminated fuel may affect the operation of one aircraft or the operation of an entire air wing. For these reasons, care must be taken in every phase of fuel handling to prevent introducing contamination into the fuel.

UNNECESSARY REPAIR WORK

Fuel carrying water or dirt can cause much extra maintenance work. For example, in a typical Navy engine overhaul shop it became necessary at one time to completely disassemble every jet engine fuel control that came into the shop because of the probability of internal damage. Ordinarily, the controls, which had been in use less than half of their overhaul time, could have simply been bench-checked to verify their performance and then returned for use on the engine. However, experience showed that over 50 percent of the fuel controls overhauled had failed because of internal corrosion, caused by water in the fuel. Such extra repair work is not confined to jet engines.

Water in the fuel can also cause erroneous readings on the aircraft's fuel quantity gages, which can be exceedingly dangerous in flight. When this happens, the probes for the quantity gages must be removed and cleaned or replaced. The fuel tanks must also be drained and wiped out to remove all traces of water.

PROBLEMS OF FUEL CONTAMINATION

The introduction of the gas turbine (jet) engine into naval aviation brought many new problems related to contamination in fuel. We have already mentioned the problem of damage to jet fuel controls caused by particles so small that they might pass through the carburetor of a reciprocating engine.

Water contamination took on a greater dimension with the introduction of jet fuels. Water can cause damage in both types of engines by corroding metal surfaces, by blocking filters and small passages when it changes to ice, and by momentarily changing the combustion quality of the fuel itself. Changing the combustion quality of the fuel can be much more serious in the jet engine since it could cause a flameout in the combustion chamber.

Jet fuels differ considerably from the aviation gasoline used in reciprocating engines. Compared to aviation gasoline, jet fuels are of high specific gravity (they weigh more); they are of higher viscosity (they flow more slowly); and they are harder to separate from water.

Jet fuels have more ability to get behind rust flakes on the side of a tank. Jet fuels retain rust or other particles longer than aviation gasoline. As shown later in figure 4-3, the particles rate of settling is much slower in jet fuels than it is in aviation gasoline. This means that one of the most dependable methods of removing contamination–allowing particles and water to settle to the bottom of a stowage tank–is substantially slowed in jet fuels.

Jet engines develop tremendous power for their weight and size, and they consume tremendous amounts of fuel in the process. The jet engine requires about 6 or 7 times as much fuel as the reciprocating engine. This means that the jet engine must be able to handle 6 or 7 times the amount of contamination. For the engine itself to filter this amount of fuel would require that it have a filter perhaps half as large as the engine. Thus we derive a fundamental rule for handling aviation fuels: Fuel must be clean before it goes into the aircraft.

The filters in the engine are not designed to remove fine contamination or excessive amounts of contamination.

The affinity of jet fuel for water requires that the process for removing contamination be slowed down. A filter/separator is a device for removing foreign matter and water from fuel. It was found that a filter/separator rated at 225 gallons per minute capacity when processing aviation gasoline had to be downrated to 170 gallons per minute for JP-5. The reason was the greater difficulty of separating water from the jet fuel.

IMPROPER OR MIXED FUELS

Since most air stations and aircraft carriers must provide fuel for both jet and reciprocating engine aircraft, the possibility exists of fueling a reciprocating engine with jet fuel or vice versa. Only a small percentage (less than one-half of one percent) of jet fuel mixed with aviation gasoline can so reduce the antiknock quality of the gasoline that it will seriously affect engine performance. Lubricating oil mixed with gasoline will have the same effect. Aviation gasoline mistakenly mixed with jet fuel in a jet engine would not be so serious, but an engine adjusted for a particular type of fuel will not perform efficiently on another type. The addition of gasoline will make jet fuels more of a fire hazard by lowering their flashpoint.

HOSE, LINES, TANKS, AND PUMPS

Fuel hose, lines, tanks, and pumps are all prime sources of fuel contamination.

Talc is released from the inside surface of hose due to stretching and flexing during normal handling. Therefore, prior to fueling an aircraft with new hose, the hose should be flushed out thoroughly, using approved procedures.

Also, caution should be exercised with a hose located at fuel stations experiencing a low operation rate. As a result of infrequent use, talc may collect in the hose, and the hose should be treated in the same manner as a new one.

Pumps, tanks, and lines are made of materials that offer some resistance to corrosion, and JP-5 tanks are given a special internal coating; however, complete corrosion resistance is impossible to attain. Air that is trapped in the system will always have moisture, which will condense and cause rusting. In addition, AvGas systems use sea water for displacement as a safety measure to eliminate vapor space. Also, in some cases sea water will be pumped into the JP-5 tanks for trimming the ship.

The performance of the Navy's aircraft depends upon the quality of the fuel used in these aircraft. Therefore, it is up to the ABF to assure that constant vigilance in the inspection of fuel samples and proper upkeep and operation of the purification and filtering equipment are carried out.

THE HUMAN FACTOR

Equipment now in use can remove most of the contamination that may be present in a fuel. It cannot separate two mixed or blended fuels; neither can it effectively reduce the contamination below the required limits if the contaminant level is too high. Great care must be taken to prevent the introduction of contamination in all phases of fuel handling, and all steps of contamination removal must be properly performed.

Inspection and sampling procedures are the only way to ensure that the equipment is performing its function properly. Unless the equipment is properly operated and the sampling procedures are carefully followed, the problem will always remain. Thus, the most important single factor in fuel contamination prevention and removal is the awareness of the men who handle the fuel.

TYPES OF CONTAMINATION

To be acceptable for delivery to aircraft, aviation fuels must be clean and bright and contain not more than 5 ppm free water when measured with the AEL Mk I free water detector. The terms "clean" and "bright" have no relation to the natural color of the fuel or the dye color added to aviation gasoline. (Jet fuels are not dyed and vary from clear, water-white to straw colored.) "Clean" means the absence of any cloud, emulsion, visible sediment, or free water. "Bright" means the fuel has a shiny, sparkling appearance. A cloud, haze, specks of particulate matter, or entrained water indicate that the fuel is unsuitable and point to a probable breakdown in fuel handling equipment or procedures. Steps should be taken to find the source of trouble and corrective measures taken immediately. See figure 4-1 for the various types of contamination that may be detected visually. The first sample of fuel in this illustration is an acceptable fuel.

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Figure 4-1.—Samples of JP-5 showing the common type of visual contamination. The air bubbles are not contaminants; they are pointed out here for information only.

WATER

Water in fuels may be either fresh or saline and may be present either as dissolved or free water. Dissolved water is water in solution in the fuel and not visible. Free water may be in the form of a cloud, emulsion, droplets, or in gross amounts in the bottom of a tank or container. Any form of free water can cause icing in the aircraft fuel system, malfunctioning of fuel quantity probes, and corrosion of fuel system components. Saline water will promote corrosion much more rapidly than fresh water.

Ordinarily, a cloud denotes water. Occasionally, a cloud denotes excessive amounts of fine sediment or finely dispersed stabilized emulsion. Fuel containing a cloud from either cause is not acceptable. (See fig. 4-2.) When "clean" and "bright" fuel cools, a cloud may form, indicating that dissolved water has precipitated out. This "precipitation cloud" represents a very slight amount of fresh water.

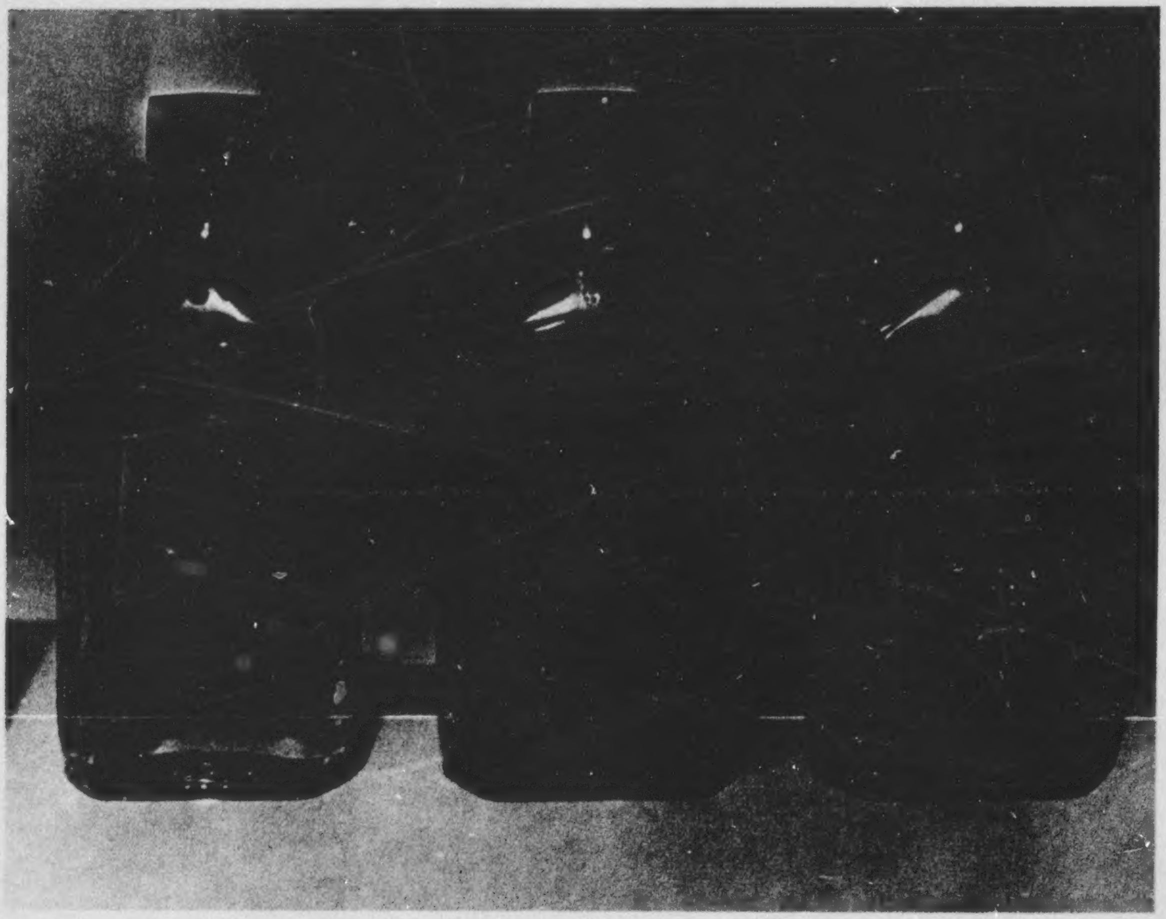

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Figure 4-2.—Degrees of cloudiness in JP-5. Sample on left is clean and bright, the only acceptable fuel for aircraft. The two samples on the right are clouded by fine particles or droplets of water.

Even a cloud is not permissible in fuel delivered to aircraft. A "precipitation cloud" can be removed by a properly operating filter/separator; the fuel should be drained back upstream of the filter/separator or recirculated to remove the cloud. Any cloud which persists in spite of recirculating must be presumed to indicate a failure or malfunction of the filter/separators, since a cloud is often the first indication of such failure. This requires replacement of the filter/separator elements and complete stripping of water and emulsion from the source tank.

SEDIMENT

Sediment appears as dust, powder, fibrous material, grains, flakes, or stain. Specks or granules of sediment indicate particles in the visible size range, i.e., approximately 40 microns or larger in size. (See fig. 4-3.) The presence of any appreciable number of such particles indicates either a malfunction of the filter/separators or a source of contamination downstream of the filter/separator, or else an improperly cleaned sample container. Even with the most efficient filter/separators and careful fuel handling, an occasional visible particle will be encountered. These strays are usually due to particle migration through the filter media and may represent no particular problem to the engine or fuel control. The sediment ordinarily encountered is an extremely fine powder, rouge, or silt. The two principal components of this fine sediment are normally sand and rust.

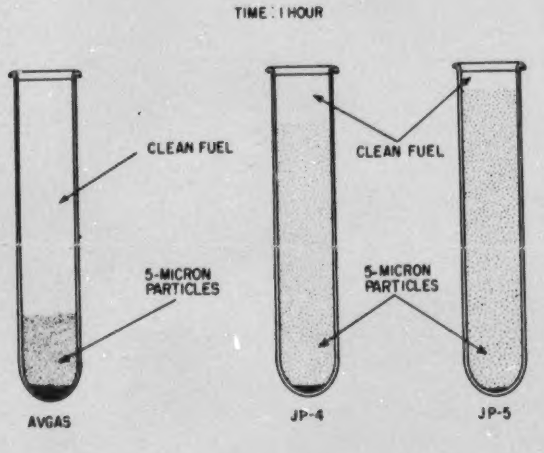

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Figure 4-3.–Comparison of particle's rate of settling in three types of fuel.

Sediment includes both organic and inorganic matter. The presence of appreciable quantities of fibrous materials (close to naked eye visibility) is usually indicative of filter element breakdown, either because of a ruptured element or mechanical disintegration of a component in the system. Usually, high metal content of relatively large particles suggests a mechanical failure somewhere in the system which is necessarily not limited to a metallic filter failure.

In a clean sample of fuel, sediment should not be visible except upon the most meticulous inspection. Persistent presence of sediment is suspect and requires that appropriate surveillance tests and corrective measures be applied to the fuel handling system.

Sediment or solid contamination can be separated into two categories: (1) coarse sediment and (2) fine sediment.

Coarse Sediment

Sediment that can be seen and that easily settles out of fuel or can be removed by adequate filtration is coarse sediment. The minimum recommended quiescent settling time is one hour for each foot of depth for AvGas and 24 hours per stowage tank for JP-5. There is no required settling time for JP-5 service tanks. Figure 4-3 shows a comparison of particles rate of settling in aviation gasoline and jet fuels. Ordinarily, particles 10 microns in size and larger are regarded as coarse sediment. (See fig. 4-3.)

Coarse particles clog orifices and wedge in sliding valve clearances and shoulders, causing malfunctions and excessive wear of fuel controls and metering equipment. They are also effective in clogging nozzle screens and other fine screens throughout the aircraft fuel system.

Fine Sediment

Particles smaller than 10 microns may be defined as fine sediment. (See fig. 4-4.)

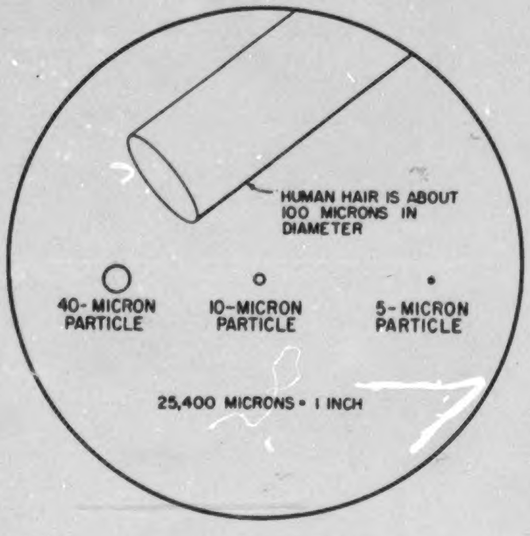

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Figure 4-4.—Enlargement of small particles and comparison to human hair.

Ninety-eight percent of the fine sediment in fuel can be removed by proper settling, filtration, and centrifuging. Particles in this range accumulate throughout fuel controls, appearing as a dark shellac-like surface on sliding valves, and may also be centrifuged out in rotating chambers as sludge-like matter, causing sluggish operation of fuel metering equipment. Fine particles are not visible to the naked eye as distinct or separate particles; they will, however, scatter light and may appear as point flashes of light or a slight haze in fuel.

Maximum possible settling time should be allowed in fuel tanks after filling to allow reasonable settlement of water and sediment.

MICROBIOLOGICAL GROWTH

Microbiological growth consists of living organisms that grow at a fuel/water interface. These organisms include protozoa, fungus, and bacteria, but fungus is the major constituent and the cause of most problems associated with microbiological contamination of jet fuels. Fungus is a vegetable life; it holds rust and water in suspension and is an effective stabilizing agent for fuel-water emulsion. It clings to glass and metal surfaces and can cause erroneous readings in fuel quantity systems, sluggish fuel control operation, and sticking of flow dividers. Microbiological growth is generally found wherever pockets of water exist in fuel tanks. It usually has a brown, black, or gray color and a stringy, fibrous-like appearance.

For microorganisms to develop in jet fuels, free water must be present. Traces of metallic elements are also necessary, but water is the key ingredient. Without water there is no growth. Remove any free water and growth ceases.

Microorganisms in jet fuel can cause severe corrosion damage to metal aircraft fuel tanks. Organic acids, or other byproducts produced by the growth of fungi or bacteria, react chemically with certain matter contained within the fuel to penetrate tank coatings. Once the coating is penetrated, the metal tank is attacked.

Microbiological growth causes fouling of aircraft fuel system filters and erratic operation of fuel-quantity probes. Microbiological contamination is more prevalent in tropical and semitropical climates due to the more favorable temperature and higher humidity. The presence of microbiological growth in fuel being delivered to an aircraft is a reliable indication of failure of the fuel system cleanup equipment.

The fuel from an aircraft suspected of having microbiological contamination must not be defueled into a clean system. Once a fuel system is contaminated with microbiological growth the organisms will continue to multiply until the system is thoroughly cleaned.

EMULSIONS

Emulsions are liquids suspended in other liquids. There are two types of emulsions—water-in-fuel and fuel-in-water or "inverse" emulsions.

The water-in-fuel emulsion is the most common of emulsions encountered by fuel handlers. It appears as a light-to-heavy cloud in the fuel. (See the second and third bottles of fuel illustrated in figure 4-1.) This type of emulsion may break down and settle to the bottom of the sample container at any time ranging from a few minutes to a week, depending on the nature of the emulsion. Other types of contamination in the fuel tend to stabilize the emulsion, causing it to last a longer period of time. Any fuel containing a cloud is suspect of being contaminated and should not be used to fuel aircraft.

A fuel-in-water or "inverse" emulsion is reddish, grayish, or blackish in color. The color is due to the stabilizing agent that must be present in this type of emulsion. The stabilizing agent is usually red rust (Fe_2O_3) or black rust (Fe_3O_4). It may also contain surface active agents and/or fungus (microbiological growth) which hold rust and water and is an effective stabilizing agent for fuel-in-water emulsions. This type of emulsion is very sticky or gummy and will adhere to most materials with which it comes in contact. A fuel-in-water emulsion always contains 30-50 percent fuel, 50-70 percent water, and a stabilizing agent. This is an obviously contaminated fuel when found, but it will cling to the sides of a tank so that it may not be noticed when a sample of fuel is dipped out or drained from the tank.

SURFACTANTS

Surfactant is a contraction of the words "surface active agent." A surface active agent, or surfactant, is a substance that causes a marked reduction in the interfacial tension of liquids. A surfactant in fuel causes the fuel and any water that contacts it to mix more easily and become much harder to separate. Surfactants disperse both water and dirt in fuel and in some cases form very stable emulsions or slimes.

The surfactants that appear in aviation fuels are usually the sulfonates or naphthenates of sodium. These can be present as naturally occurring materials in the crude oil or as residual refinery treating materials. Refinery processing must be such that it removes all traces of these materials, or poor quality fuel will result.

Many other materials are also surface active. The list includes common household detergents, cleaning compounds used to clean fuel stowage tanks and carrier vehicles, greases used to lubricate valves, and corrosion inhibitors used in petroleum products to reduce rusting of pipelines and tanks.

Surfactants in aviation fuel can be a major problem, for these materials accumulate and concentrate in the coalescer elements of filter/separators, destroying the ability of the elements to coalesce and remove water from fuel. Concentrations of less than one part per million of a surfactant in jet fuel have been known to cause malfunctioning of coalescer elements. Elements so affected will pass free water and suspended particulate matter.

Surfactants are also associated with microbiological slime growths. It is not necessary that they be present for microorganisms to flourish, but they promote luxuriant growth by aiding the mixing and emulsifying of fuel and water. Microorganisms need free water to multiply and grow. Surfactants help them to get it.

The great problem with surfactants is that they quite often are not detected in aviation fuels until after they have "poisoned" filter/separators, which in turn have allowed water and/or slime to be delivered to aircraft. There are laboratory tests for surfactants in fuel, but as yet there are no accurate field tests. However, a surfactant problem can usually be detected by one or more of the following observations:

1. Dark, red-brown, or black water in filter/separator sump drains, refueler sump drains, or pipeline low-point drains.
2. Excess quantities of dirt and/or free water in the fuel at dispensing points or downstream of filter/separators.
3. Prescribed settling time in stowage tanks not yielding a clear, bright fuel.
4. Dark or black water and/or slime in drawoffs from stowage tank bottoms.
5. Triggering of fuel monitors if installed in delivery system.

No two cases of surfactant contamination in fuel systems are ever exactly alike. However, some general measures can be used to correct and control this type of contamination:

1. Change monitor fuses.
2. Change filter/separator elements and clean out filter/separator cases.
3. Clean out pipelines.
4. Remove contaminated tanks from service and clean thoroughly.

5. Recirculate fuel, returning it to system upstream of as many filter/separators as possible.

6. Investigate source of contamination and eliminate it. Notify cognizant Military Inspection Service and Navy Fuel Supply Office if fuel is contaminated on receipt.

MIXED FUELS

The inadvertent mixing of two or more different fuels is known as commingling. Most hydrocarbon products (greases, oils, alcohols, etc.) are readily capable of mixing with other hydrocarbon products and cannot be separated by mechanical means such as settling, filtering, or centrifuging. A fuel that has been contaminated by commingling with another petroleum product is extremely dangerous whether in stowage or in use, because there may be no apparent visual or odor change.

This type of contamination is usually due to carelessness or a misunderstanding in the operations of a fuel system. Most aviation fuels systems are segregated from each other and from other types of fuel systems. In some cases the piping of one fuel system may be interconnected with another system through valves, blanks, or flanges. The inadvertent opening of a wrong valve can result in commingling the two different products.

In other instances, fuel may be pumped into a tank that has contained another product without the tank being properly cleaned. The small amount of the other product may be enough to contaminate the fuel.

JP-5 contaminated with other jet fuels or gasoline must not be stored aboard aircraft carriers unless a laboratory test indicates that the flash point is within the allowable limits of the specifications. Aviation gasoline containing more than 0.5 percent by volume of jet fuel may thus be reduced below the allowable limits in knock rating.

Due to the problem in detecting commingled fuels, great care must be taken where two different fuels are handled in close association.

INSPECTION OF FUEL

The fuel systems and mobile refuelers in use at the present time by the Navy are designed to deliver an acceptable uncontaminated fuel safely into the tanks of an aircraft when they are properly operated. To ensure that this fueling equipment is working properly and is being operated properly, samples of the fuel must be taken at several points and after each step in the operation.

SAMPLES

A sample is a small part of a quantity of a fuel representative of the quality or condition of the total quantity of that fuel, suitable for visual or chemical examination.

The ABF2 is required to know the procedures for the drawing of samples and making an examination of the samples for visual contamination. A sample must be taken in such a manner and from such a location that the sample will be truly representative of the fuel sampled.

Types of Samples

There are many types of samples and sampling methods used in the inspection of fuels; however, only the four most common ones are discussed here. A detailed description of the other types of samples is given in the Quality Surveillance Handbook for Fuels and Lubricants, Mil-Hdbk 200D.

COMPOSITE SAMPLE.–A single tank composite sample is a blend of samples taken from the upper, middle, and lower levels of a tank's contents. A multiple tank composite sample is a blend of individual all-levels samples from each of the tanks that contain the same type of product being sampled, in proportion to the volume of the product in each tank.

ALL-LEVELS SAMPLE.–This sample is one obtained by submerging a closed sampler (thief) to a point as near as possible to the drawoff level, then opening the sampler and raising it at such a rate that it is nearly but not quite full as it emerges from the liquid.

LINE SAMPLE.–A line sample is one taken from a pipe line or hose at or near the discharge point before commencing delivery and during the first few minutes of pumping. This sample is taken to give a visual identification of the fuel.

REPRESENTATIVE SAMPLE.–This type of sample is used for packaged stocks of fuel. One container from a large stock of packaged fuel, where all are of the same age and grade, may be selected as being a representative of the entire stock. Where the containers of fuel are small and suitable for shipment, a container of fuel is taken as the sample without it being opened. For drums of fuel the sample is drawn from one drum.

Sampling Procedures

Proper sampling and labeling of petroleum products is as important to fuels inspection as proper testing. Improper containers of poorly drawn samples or incorrectly identified samples can cause laboratory results to be meaningless, or worse, misleading.

Some cardinal rules in sampling follow.

1. The sampler's hands or gloves must be clean.
2. Sample containers must be meticulously clean. They should be thoroughly cleaned and inspected prior to use. Prior to sampling, the clean container should be rinsed and flushed several times with the fuel being sampled.
3. Samples must be as representative of the product being sampled as possible. Samples of fuel being delivered to aircraft should be taken from the fueling nozzle and during actual fueling operations. Samples taken to test fixed filter/separators should be taken at the filter outlet.
4. Samples should be capped promptly using an approved cap. Do not use sealing wax, rubber gaskets, or caps with wax seals.
5. Samples should be drawn from connections in vertical pipe runs where practicable. If they must be drawn from horizontal runs, the connection should be halfway between the top and the bottom of the pipe.
6. Samples should be taken with the system operating at normal flow rates and at a steady state if possible.
7. To prevent leakage due to increased pressure caused by thermal expansion of the product, do not fill any container above 90-percent capacity.
8. Containers such as drums should be sampled with a thief sampler and not by tilting. Care must be taken to remove all foreign matter from the area before the plug is removed from the drum.
9. For nozzle samples, the sample should be taken from the overwing nozzle during or immediately after the fueling of an aircraft. Pressure nozzles have a pressure gage tap into which a petcock may be inserted. A sample can then be taken while the aircraft is being fueled.

Sizes of Samples

The minimum size sample container for taking samples of fuel is 1 quart. This size sample is of sufficient size for sediment, water, and flashpoint tests only. For other types of tests, the sample submitted should be at least 1 gallon. Sample containers for sediment and water tests must always be glass with nonmetallic tops.

Identification of Samples

Proper identification and accurate records of samples are absolutely necessary so that the test results may be correlated with the samples submitted.

The following should be used as a guide for sample identification:

1. Sample serial number. (Activities number.)
2. Type fuel (JP-5, 115/145, etc.)
3. Name and location of activity.
4. Date sample taken.
5. Location of sample point (nozzle sample refueler No., tank No., etc.).
6. Quantity of material represented, if applicable.
7. Classification of sample (routine or special–see below).

8. Name of person taking sample.
9. Tests required.
10. Remarks.

SAMPLE CLASSIFICATION.–Samples are classified either "ROUTINE" or "SPECIAL." ROUTINE samples are taken when no fuel problems or aircraft problems attributable to fuel are known or suspected. An example would be the periodic samples taken as a part of a quality surveillance program. These should be tested for sediment and water, and, for JP-5, flashpoint. SPECIAL samples are submitted for test because the quality of the fuel is suspected either as the result of aircraft malfunctions or other information. SPECIAL samples should have the highest priority in handling, testing, and reporting.

Container

The container for the drawing of visual samples should be at least 1 quart in size, round in shape, and made of clear glass. The top should be as large as possible to aid in drawing the sample without spilling the fuel. The cleaning procedures previously described under sampling procedures should always be carried out for the taking of visual samples.

Visual Inspection Procedures

Since very small percentages of water or foreign matter can cause trouble, the sampling and inspection of fuel must be done carefully. Proceed as follows:

1. The color of the sample should be the first thing checked when making a visual inspection. The color of the sample must agree with the color for the grade of fuel that the system is supposed to carry. The color of the fuel may have changed due to mixing with another petroleum product. A definite yellow cast or darkening of color in gasolines may be caused by lubricating oil, diesel oil, jet fuels, or NSFO (Navy Special Fuel Oil, commonly called "black oil"). Lubricating oil and NSFO can also cause a change in color in jet fuels. One part NSFO in 300 parts of JP-5 will turn the JP-5 black. Since the percentage of another petroleum product in a fuel may be so small that it cannot be detected visually, yet can make it unacceptable for use, no offcolor fuel should be used until an analysis is made to determine its usability.

2. The second check of the sample should be for water. The sample should be free of any cloud. See the first sample illustrated in figure 4-1 for an example of acceptable fuel for this visual check. The sample must be clear enough that newsprint can be read through a 1-quart sample.

If the fuel is cloudy and the cloud disappears at the bottom, air is present. If the cloud disappears at the top, water is present. If the cloud does not commence clearing in a few minutes, it is due to free water or very fine particulate matter.

Any fuel containing a cloud that does not disappear in a few minutes after it is drawn or contains any visible water should not be used to fuel aircraft.

3. The third check should be for sediment. Swirl the sample so that a vortex is formed. All sediment that has settled will accumulate on the bottom of the bottle directly beneath the vortex. At the very most, the total sediment should be only a point or spot of silt. In a quart sample, the sediment should be no more than a slight smudge if picked up on a fingertip.

Results

If any contamination is discovered during the visual inspection procedure, stop the fueling operation immediately and notify the pilot of the aircraft, the fuel officer, or the duty officer. They will decide whether the fuel is acceptable. If not acceptable, they will determine the action to be taken.

Action

A contaminated sample should be suitably tagged and retained until it is determined that a laboratory analysis of the sample is not required. When any contamination is found, another sample should be taken, preferably in a new sample container, taking care to ensure that the container is thoroughly clean before drawing the sample. Once contamination is found and the system placed out of use, a check must be made for the source and cause of the contamination and the cause corrected before the system is placed in use again. The type of contamination discovered will usually give a clue to the source and cause. Some of these indications are as follows:

1. Mixed or commingled fuels–Valve or blank flange open between two different systems or a leak through a bulkhead where two tanks containing different fuels are adjacent.
2. Water–The filter/separator elements are ruptured or contaminated. Large amounts of water would also indicate that the filter/separator water slug control valve was not operating and that water stripping operations for the service tanks were inadequately performed.
3. Sediment and microbiological growth–The filter/separator elements are ruptured or contaminated. Large amounts of sediment or microbiological growth would also indicate that the stowage tanks and service tanks need cleaning.

NOTE: For further information on aviation fuels contamination, refer to the current NAVAIRINST 10340 (Series).

CONTAMINATED FUEL DETECTOR (AEL MK III)

The contaminated fuel detector (fig. 4-5) is a portable instrument which will determine the quantity of solid contamination present in aircraft fuels.

The detector consists of a fuel sample container, a fuel filtration system (employing the Millipore filter), and a light transmission system for determining the quantity of solid contaminant on the Millipore filter. The detector is reliable, accurate, rugged, and capable of providing a quick determination of the quantity of solid contamination in aircraft fuels.

The contaminated fuel detector is a self-contained unit. All components necessary for filtration and measuring of transmitted light are incorporated into one serviceable package. A drawer, compartments, and holders are provided for storage of filters, sampling bottles, filter holder, power cable, and vital spare parts.

A fuel sample from the polyethylene sampling bottle is passed through the detachable Millipore filter holder, into the aluminum fuel flask. To speed up filtration, a vacuum pump is connected to the fuel flask. After the fuel sample (800 ml.) is filtered into the flask, the vacuum pump is stopped and the fuel flask drained by turning the drain cock handle. Millipore filters are evaluated by placing them in a receptacle where they are illuminated from underneath.

The level of fuel contamination is measured by using the principle of light transmission through the Millipore filter. A sample of fuel is filtered through the Millipore membrane. Contaminating particles are retained on the surface of the membrane. If a beam of light is directed through the membrane, part of the light is absorbed by particles of solid contaminant. In order to increase accuracy, and to eliminate any fuel color effect, two Millipore filters are used in series. The first filter traps the solid contaminant, plus any fuel effects, whereas the second filter is subjected to clean fuel and retains only the fuel color effect. Thus, the difference between light transmission through the two filters depends only on the amount of solid contamination. By measuring the difference between the amount of light transmitted through the contaminated and clear membrane, it is possible to establish the level of contamination in fuel. The amount of light transmitted through the Millipore filter is measured with a photovoltaic cell, connected to a milliammeter. A constant voltage transformer and rheostat are provided for controlling the light intensity. For additional detailed information, see Technical Manual, NAVSHIPS 315-0145, Contaminated Fuel Detector AEL Mk III, furnished with each detector.

Operating Instructions

The filtration is as follows:

1. Make sure that the fuel flask is empty. If necessary, drain the fuel flask by turning the drain cock handle and allowing the fuel to drain through the tubing provided.

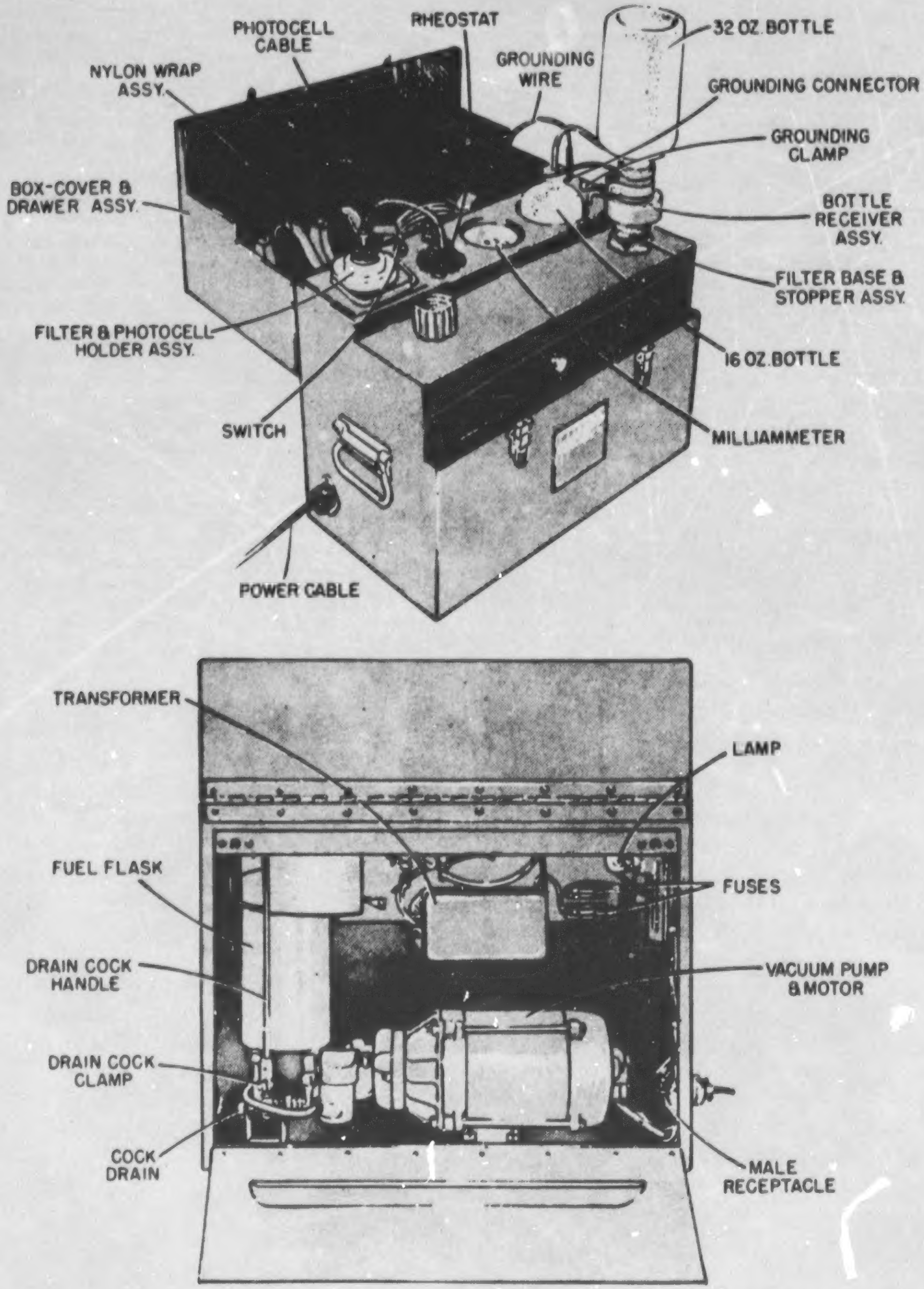
PHOTOCELL CABLE
RHEOSTAT
32 OZ. BOTTLE
NYLON WRAP ASSY.
GROUNDING WIRE
GROUNDING CONNECTOR
GROUNDING CLAMP
BOX-COVER & DRAWER ASSY.
BOTTLE RECEIVER ASSY.
FILTER BASE & STOPPER ASSY.
FILTER & PHOTOCELL HOLDER ASSY.
16 OZ. BOTTLE
SWITCH
MILLIAMMETER
POWER CABLE
TRANSFORMER
LAMP
FUEL FLASK
FUSES
DRAIN COCK HANDLE
VACUUM PUMP & MOTOR
DRAIN COCK CLAMP
COCK DRAIN
MALE RECEPTACLE

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Figure 4-5.—Contaminated fuel detector (AEL Mk III).

2. Close the drain cock.

3. The filter holder and bottle receiver assembly located in the lid, should be disassembled into its two components by turning the center locking ring in a counterclockwise direction and pulling the two sections apart. The section with the rubber stopper is the filter holder and should be inserted into the opening in the fuel flask.

4. Place two Millipore filters right side up in the filter holder. Reassemble the filter holder and bottle receiver assembly by placing the bottle receiver component on top of the filter holder component and turning the locking ring in a clockwise direction. Be careful to rotate the ring only; otherwise, the filters may be torn.

5. The filter holder and bottle receiver assembly is then removed from the fuel flask, and the bottle receiver end is placed over the top of the 32-ounce polyethylene bottle, filled to the 800-ml mark with fuel. All of the threaded portion of the bottle top should be inserted into the bottle receiver.

6. The ground wire attached to the filter holder and bottle receiver assembly should be inserted into the opening provided for it adjacent to the drain arm. The pump switch should be turned on.

7. The entire assembly (filter holder, bottle receiver, and fuel sample bottle) is then picked up as a unit, inverted, and then inserted (filter holder end) into the fuel flask. After all the fuel has drained from the bottle, remove the bottle. After all the fuel has gone through the filters, and the bottle receiver component has been removed exposing the filters, stop the pump.

8. Drain the fuel from the flask through the tygon tubing.

Measuring the light transmission is as follows:

1. Turn on the light switch.

2. Allow to warm up for two to three minutes. (Light should be turned on during above filtration cycle, to allow for warmup period.)

3. With no filter in the receptacle, swing the photocell into measuring position.

4. Using the rheostat knob, adjust the light intensity until a reading of 0.6 is obtained on the milliammeter.

5. Using forceps, pick up the contaminated filter and wet it with clean JP-5 from the 16-ounce polyethylene bottle. Wetting is accomplished by making a puddle of clean JP-5 on the working surface and laying the filter in it so that the entire filter becomes wet with fuel.

6. Lift the photocell and, using forceps, place the contaminated filter in the receptacle.

7. Swing the photocell back into measuring position.

8. Record the reading of the milliammeter.

9. Remove the filter.

10. Repeat steps No. 5 through 9, using the clean filter.

11. Subtract the contaminated filter reading from the clean filter reading.

12. From the calibration curve find corresponding value of contamination in milligrams per liter, or milligrams per gallon.

NOTE: The contaminated fuel detector is NOT ready for use when received; therefore, the unit must be calibrated upon receipt and every 3 months thereafter. The calibration curve that comes with each fuel detector will then indicate that the fuel tested either meets the minimum requirements or is unacceptable.

FREE WATER DETECTOR (AEL MK I)

The free water detector was developed to accurately measure the amount of free water in AvGas and JP-5 fuels. This detector is used in conjunction with the Contaminated Fuel Detector in the normal fuel inspection and surveillances program, and the test should be executed as soon as possible following sampling. (See fig. 4-6.)

The free water detector consists of an ultraviolet light source, a set of standards indicating 0, 5, 10, and 20 parts per million, and water detector pads.

A test sample of fuel is passed through a chemically treated filter pad in the filter holder of the Mark III detector. The chemical on the pad is sensitive to any free water in the fuel, producing a fluorescent pattern readily visible

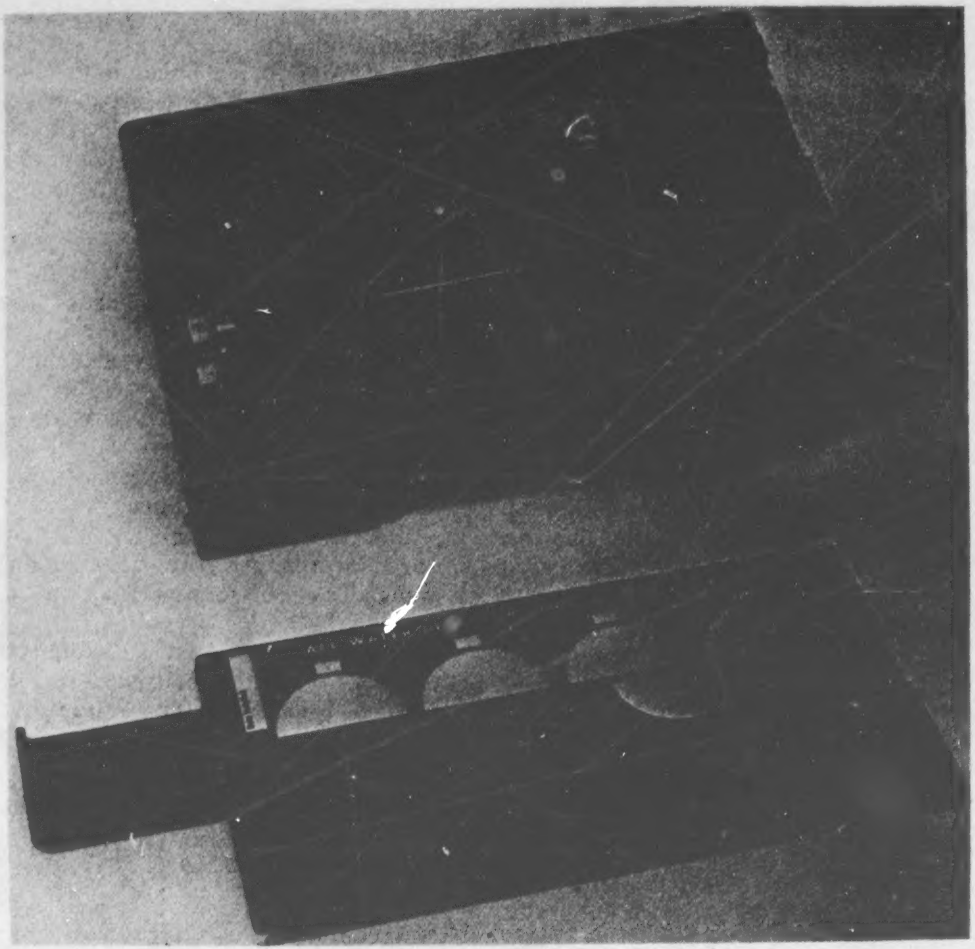

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Figure 4-6.—Free water detector (AEL Mk I).

under ultraviolet light. After filtration, the pad is examined under ultraviolet light contained in the viewer kit. The amount of free water in the fuel is determined by the intensity of fluorescence on the test pad. Visual comparison is made with a series of standards representing known quantities of water.

Instructions for Using the AEL Free Water Detector

1. Mark the polyethylene bottle used with the AEL Contaminated Fuel Detector Mk III 3¼ inches from the bottom. When the bottle is filled to this mark, a 500-cc sample will be obtained.

2. Fill the polyethylene sample bottle to the 500-cc mark with fuel to be tested.

3. Open a free water detector envelope and place the detector pad (orange side up) on the contaminated fuel detector base. Attach the bottle receiver to the filter base and plug in the ground wire jack.

CAUTION: Handle the detector pad with forceps only.

4. Check to see that the contaminated fuel detector fuel reservoir is empty and that the drain valve is closed.

5. Shake the bottle containing the 500-cc fuel sample vigorously for approximately 30 seconds.

6. Immediately after shaking, turn the vacuum pump on, unscrew the bottle cap, place the bottle receiver firmly over the end of the bottle, and insert the filter base into the contaminated fuel detector. (This step should be accomplished in as short a time as possible in order to keep any free water in suspension.)

7. After the 500-cc sample has passed through the detector pad, turn off the vacuum pump IMMEDIATELY, and remove the bottle and bottle receiver.

NOTE: Under no circumstances continue to draw air through the detector pad. Remove the pad from the filter base with forceps and place it (orange side up) in the free water detector slide depression.

8. Light the ultraviolet bulb in the free water detector by holding the light switch in the ON position and insert the slide containing the test pad.

9. Look through the view port of the box and compare the brightness of the test pad with that of the set of standards to determine the amount of free water. Free water content is indicated in parts per million (ppm) by the numbers located directly above the standards. Results should be reported as "No Free Water" or as actual free water content (estimated to the nearest part per million.)

10. If the result is over 20 ppm, take a new sample of one-half the standard sample and double the answer.

NOTE: The "standards" card in the free water detector must be replaced after 6 months of use. Two spare sets have been included with the kit for this purpose.

The standards card in the box, when received, should be marked with the date on which the detector is first put into use.

Spare Parts: Free water detector kits, spare parts and material are available from the Navy Supply System.

SHIPBOARD TANK CLEANING

Empty, open, and inspect each JP-5 stowage and service tank at least once each 6 months, when undergoing shipyard overhaul, or when tests of samples indicate the need. Accomplish this on a tank-by-tank basis in order to permit retaining maximum JP-5 capacity onboard.

If inspection reveals that bulkheads, stiffeners, and flat surfaces have collected solids to the extent that the solids are readily visible, wash down the tanks with a fire hose. Remove wash water from stowage tanks by the main drainage eductors; remove wash water from service tanks with the JP-5 motor-driven stripping pumps. Conduct the above operation at sea. If conducted in port, assistance by a shore activity and changes in the wash water removal procedures to prevent harbor pollution will be required.

Full compliance with the procedures of chapters 9004 and 9920, NAVSHIPS Technical Manual, is required in carrying out the above inspections or cleanings.

Chapter 9920 of NAVSHIPS Technical Manual states, "No person shall enter any closed compartment or poorly-ventilated space aboard a naval or Navy-operated vessel unless and until the GAS-FREE ENGINEER or his authorized representative has indicated that the applicable directions detailed in chapter 9920 of NAVSHIPS Technical Manual have been complied with; and that the danger of poisoning or suffocation, or ignition of flammable gases has been eliminated or reduced to the lowest practical minimum."

The health hazards of aviation fuels are detailed in chapter 3 of this training manual.

Due to the ease with which deposits can be washed out by fire hose, steaming is not required, and steam should not be employed, since it may damage the tank coatings.

JP-5 has a minimum required flashpoint of 140° F. Therefore it is not anticipated that an explosive mixture will exist in the tank or be discharged to other compartments during the ventilation process. Because the possibility exists that JP-5 may have been contaminated by more volatile (AvGas or JP-4) products, flashpoints tests in accordance with chapter 9550, NAVSHIPS Technical Manual, should be made to ensure that contamination has not occurred.

Never clean JP-5 tanks or other parts of an aviation fuels system by the chemical cleaning processes using solvent-emulsifier-type compounds or detergents. Small quantities of the chemical-type cleaners remaining in the tanks after cleaning operations will contaminate the coalescer elements in the filter/separator and destroy their coalescing ability.

FILTER ELEMENT CHANGING

Filter/separators are installed in aviation fuel systems to remove solid contaminants and free water from the fuel. Basically, the equipment is a two-stage unit consisting of a coalescer stage and a separator stage. Each stage is made up of replaceable elements, the number of which is determined by considerations such as the capacity (gpm) of the element and its sediment-retaining capacity. Coalescer elements filter solids from the fuel and cause the small particles of undissolved water in the fuel to combine (coalesce) into larger drops of water which will settle to the filter sump due to their weight. Separator elements are provided downstream of the coalescer elements to remove any water droplets that may have carried along in the fuel without settling. Water which has accumulated in the filter sump is removed through a drain line, either automatically or manually.

The life of the coalescer elements and of the separator elements is basically dependent on the condition of the fuel. Water in the fuel has less of an effect on shortening the life of the coalescer elements than does solid contamination (sediment). Coalescer elements can collect only a limited amount of solids before they will fail to perform their solids-filtering and water-coalescing functions. Only by replacing these elements prior to this point can element failure and subsequent fuel-system contamination be prevented.

TRANSFER FILTERS

A daily log of pressure drop and gallons pumped is kept for each transfer filter/separator. Coalescer elements are replaced when the pressure drop limit is reached or at 400,000 gallons, whichever occurs first. No increase in pressure drop across the coalescer elements is an indication than one or more coalescer elements are faulty.

Pressure drop limits for coalescer elements are included in an instruction sheet contained in each element packing container.

CAUTION: The filters should be checked with a combustible gas indicator and the filter space well ventilated prior to changing the elements. The old elements should be removed from the space as soon as possible and tested as described later in this chapter.

When coalescer elements are changed, the separator elements are to be cleaned if any dirt is on the element. If separator elements are clean, they are tested and only the defective elements replaced. Replacement elements are tested before installation.

The ship should deploy with a new set of coalescer and separator elements in each transfer filter and have 500 percent of non-installed elements onboard as spares for the transfer filters.

CENTRIFUGAL PURIFIERS

The centrifugal purifier is provided on some of the older CVAs and all CVAs and LPHs of new construction. The centrifugal purifier, when installed, is used in place of or replaces the transfer filter.

This is a constant efficiency type of separator; that is, it achieves the same degree of efficiency at the end of a run as at the beginning. The reason for the constant efficiency is that the accumulated solids removed from the fuel are stored away from the separation zone.

Additional information on the centrifugal purifier is given in chapter 6 of this training manual and in *ABF 1 & C,* NAVEDTRA 10304. Detailed information is given in Technical Manual, JF-2 Jet Fuel Centrifugal Purifier, NAVSHIPS 345-0453 and/or 345-0479.

SERVICE FILTERS

The service filter/separators should have maximum capacity (gpm) pumped through them to obtain an accurate pressure drop across the elements; therefore, it is recommended that the pressure drop not be used as the sole means for determining when coalescer elements need replacing.

Coalescer elements must be replaced at each overhaul; however, it is recommended that the coalescer elements be replaced prior to deployment or yearly. Elements are also replaced when:

1. Analysis of fuel samples indicates that solids and/or water are passing through the filter.
2. The daily sample taken from the filter sump contains solid particles.
3. The daily sample taken from the filter discharge section drain contains more water than prescribed by PMS requirements. Very small amounts of water can collect in this section of the JP-5 service filters by coming out of solution in the fuel in the service piping.

Test installed separator elements each time coalescer elements are changed and replace faulty elements. Test new elements before installation. Test only sufficient elements to complete the immediate filter/separator change.

When changing elements, ensure that all coalescer elements are from one manufacturer and all separator elements are from one manufacturer due to the different manufacturer's pressure drop characteristics. Coalescer elements of one manufacturer may, however, be used with separator elements of another manufacturer.

The ship should deploy with 110 percent of non-installed coalescer elements and 120 percent of non-installed separator elements as spares for the service filters onboard.

TESTS OF FILTER ELEMENTS

Coalescer Element

The purpose is to determine that the element will coalesce finely divided water in the fuel into large drops and that the element is free from defects.

The testing equipment consists of an open tank for fuel and water, pump, flowmeter, pressure gage, piping or flexible hose, valves, the elements to be tested, and an element mounting fixture. NOTE: This inspection test is made by flowing the fuel from the inside to the outside.

The inspection test is conducted as follows:

1. Fill the test tank with 15 gallons of JP-5, install a coalescer element on the holding assembly, and flush the system for 10 minutes.
2. Remove the strainer on the suction side of the pump, examine, and clean if necessary.
3. Drain 2½ gallons of JP-5 from the test tank and add 2½ gallons of clean fresh water. The liquid level should be between the two red indicating marks.

NOTE: Filter elements soak up large amounts of JP-5; therefore, they should be immersed in JP-5 prior to testing to eliminate the necessity of refilling the test tank.

4. Place an element to be tested on the standpipe and start the pump with the flow control valve slightly cracked open to allow a small flow rate through the element.
5. Increase the flow rate to 10 gpm maximum (the pressure will be about 4 psi); continue pumping for 3 to 5 minutes or until all air is expelled from the element. Air in the element is indicated by air bubbles coming from the outside of the element and rising to the surface of the fuel in the tank.
6. Keep the element submerged; rotate and observe water droplet formation for approximately 2 minutes.

Observations of the element are as follows:

1. If the element is good and functioning properly as a coalescer, droplets of clear water will form on the outlet surface of the element and drop off and fall to the bottom of the tank.
2. If the element has defects such as inadequate internal seals or broken paper or fiber glass, the element will not coalesce properly. This condition will be indicated by

one or more cloudy streams of uncoalesced water issuing from the element.

Permanent Separator Element Integrity Test

The purpose of this test is to determine that the Teflon-coated screen separators are structurally sound before being used. The test and the inspection are performed in the following manner:

1. Make a visual inspection of the unit for any flaws.

2. Place the unit on a smooth, even table top or workbench top in a horizontal position.

3. Using a poly hose, fill the internal portion of the unit with approximately ¼ inch of water or enough to completely cover the entire lower section along the longitudinal axis.

4. Slowly rotate the unit and inspect for leakage of water. Take special note of the seam area.

5. After the inspection, empty the water out of the unit, and allow it to dry completely before putting into use.

CAUTION: When the test is performed, do not plug one end and fill the unit with water while in a vertical position. The Teflon screen will leak with a head of approximately 1 inch or more of water.

Disposal of Filter Element and Sludge

Filter elements that have been used and/or tested in any type of aviation fuel are a considerable fire hazard. They should be removed from the filter room and disposed of as soon as possible. Those elements that have been used in gasoline are very hazardous due to the presence of lead. Sludge removed from fuel tanks during cleaning presents the same hazard as the filter elements.

At shore stations, sludge from tanks which contained nonleaded fuel (jet fuels) and filter elements may be buried, hauled to a burn pit, or to some other disposal area. They should never be mixed with other trash but always carried to the disposal area by themselves. Sludge and filter elements that are from a system that contained leaded fuels must be kept wet with water until they can be buried in an area where access can be controlled. They must never be burned as the smoke would be very poisonous. The burial pit should be deep enough to permit coverage by at least 2 feet of earth.

At sea the sludge and filter elements removed from the gasoline tanks or system should be placed in a closed container and the container weighted and sunk in deep water. Filter elements from the jet fuels system need not be placed in a closed container but should be weighted to cause them to sink. Disposal at sea should always be at least 50 miles from the nearest land.

FUEL MONITORS

The fuel monitors function as a filter, a water separator, and a full-flow fuel monitor. It permits clean, dry fuel to pass through, but acts as a positive cutoff if the fuel is contaminated water water or solids above an acceptable level.

The monitors consist of two basic parts—the housing with its inlet and outlet connections and one or more cylindrical fuses contained therein. The fuses are the working part of the monitor; their length and number determine the rate at which fuel can be flowed through the monitor. The fuses fit into sockets provided in the housing, and all the fuel has to flow through the fuses. The fuses (fig. 4-7) are tubes filled with thin, cellulose, washerlike valves which will pass clean dry fuel through thousands of minute flow passages, but will trap solids and absorb free

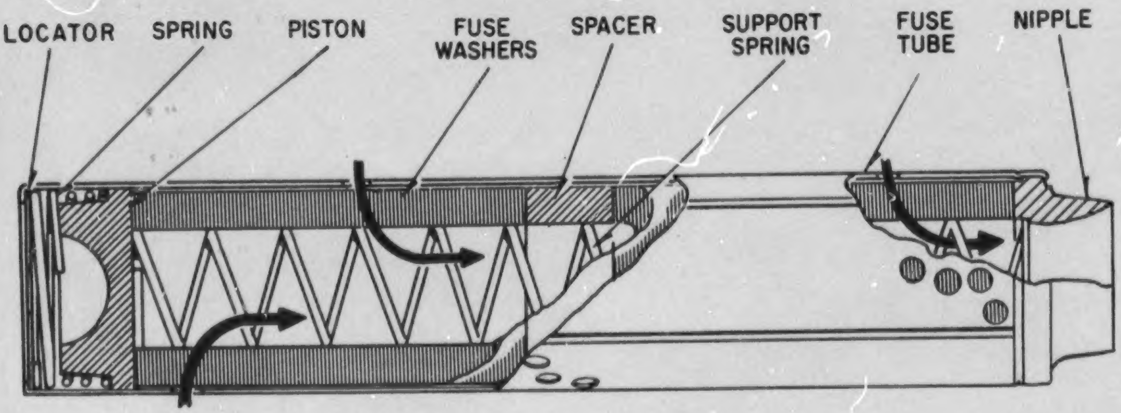

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Figure 4-7.—Monitor fuse assembly.

water. A spring-loaded polyethylene piston closes one end of the fuse assembly and compresses the washers. To the opposite end of the tube is crimped a plastic nipple which fits into the housing socket and serves as the fuse outlet port.

The surface of the washers is of predetermined roughness. Very smooth washers are alternated with washers having a ridged surface to form a stack or column with thousands of minute passages between each adjoining pair of washers.

Fuel flows through the inlet ports in the fuse tube and then through the minute flow passages between washers to the inside of the fuse, and leaves through the nipple outlet. In so doing, the fuel is stripped of all solids larger than the size of the flow passages. Solid contamination is retained on the outer edges of the fuse washers. As the solids accumulate, the resistance to flow gradually increases. The flow is reduced and the pressure differential between the fuel outside the fuse and the fuel inside the fuse increases. The increase of pressure differential exerts force on the spring-loaded piston at the end of the tube which, in turn, further compresses the washers and decreases the size of the passages between the washers. Thus, clean fuel passes freely through the fuses of the gage, but contamination is trapped.

The washers will also retain undissolved water. The smooth surface washers absorb undissolved water, and swell. This causes a slight increase in the length of the washer stack and compresses the coils of the spring to its solid length. Further water absorption and swelling of the washers flatten the ridges of the alternate washers. This decreases the size of the passages between the washers and increases the pressure differential between the fuel outside and the fuel inside the fuse. As in the case with solid contamination, the increase in pressure differential applies a greater force on the spring-loaded piston, decreasing the length of the washer stack and reducing the spaces between the washers until the fuel flow is shut off.

Once the fuses become saturated with water or plugged by solids, they have to be replaced, a simple process of removing the old fuses and plugging in new.

In addition to using standard monitor units, two conversion assemblies have been designed and approved by the Naval Air Systems Command for use in existing filter or filter/separator housings at shore-based activities. These conversion assemblies are illustrated in figures 4-8 and 4-9.

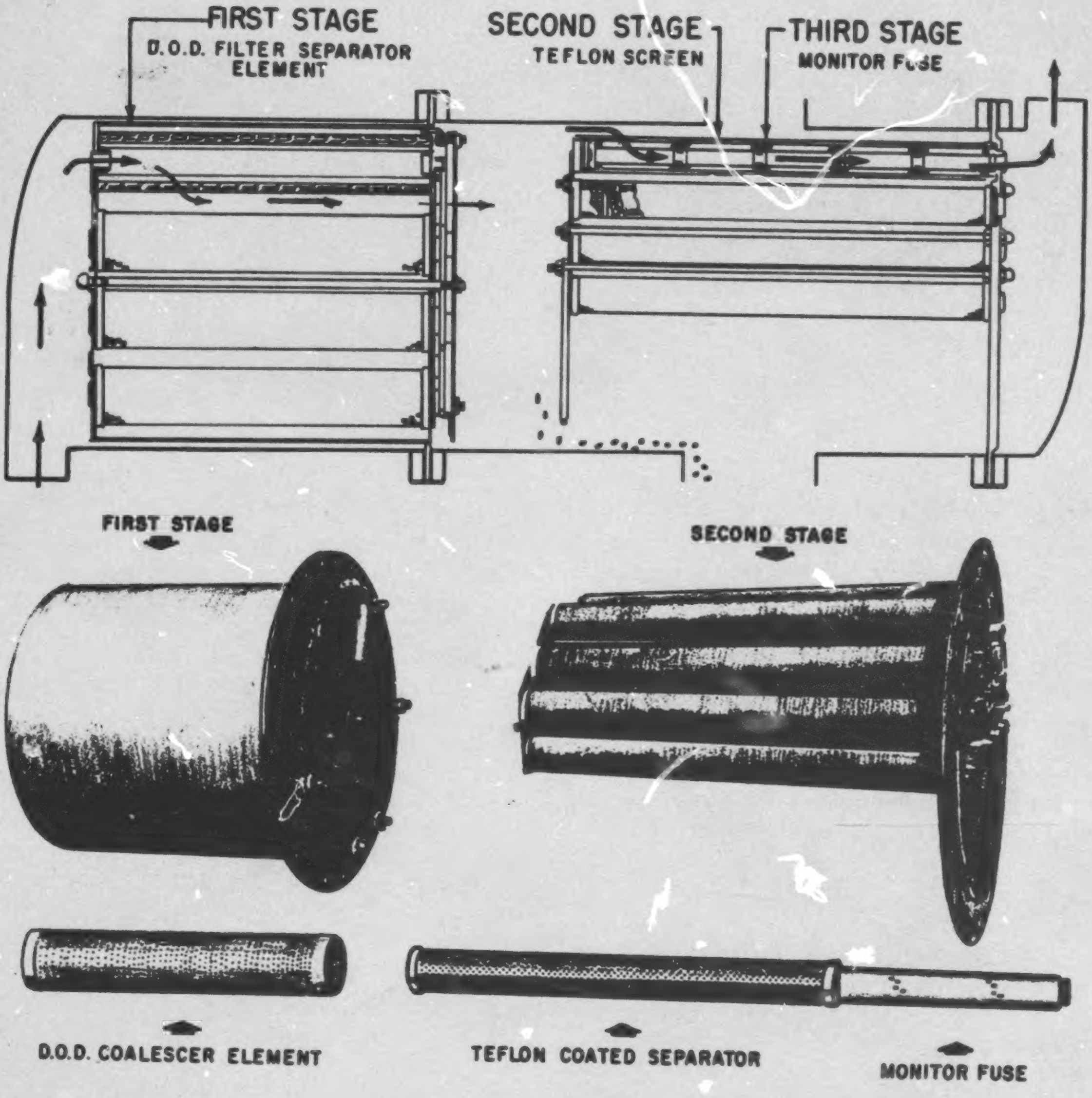
FIRST STAGE
D.O.D. FILTER SEPARATOR ELEMENT
SECOND STAGE
TEFLON SCREEN
THIRD STAGE
MONITOR FUSE
FIRST STAGE
SECOND STAGE
D.O.D. COALESCER ELEMENT
TEFLON COATED SEPARATOR
MONITOR FUSE

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Figure 4-8.--Conversion kit for 225 gpm filter/separator.

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Figure 4-9.–Conversion kit being installed in skid-mounted refueler.

Cleaning of Strainers in Fueling Nozzles

Overwing and pressure fueling nozzles are furnished with wiremesh strainers. The nozzles should be opened periodically, the strainers inspected and cleaned, or replaced where necessary. This is applicable to both gasoline and JP-5 systems. Good housekeeping requires clean strainers in the nozzles at all times to prevent pipeline sediment beyond the filter/separators from passing to aircraft fuel tanks.

CHAPTER 5

HIGH-CAPACITY GASOLINE SYSTEMS

The high-capacity aviation gasoline system was designed to receive, store, and dispense to aircraft, large quantities of a highly volatile fuel with the greatest possible safety and maximum efficiency. For this reason, a great deal of engineering has gone into the design of the AvGas tanks and distribution system for combat ships to give the greatest amount of protection possible.

The original system has proven so effective that no major changes have been required in the design of its principle of operation since it was first introduced into the fleet. There have been changes, however, in the storage and distribution capabilities to provide for greater stowage and distribution of the new primary aircraft fuel, JP-5.

With these changes came different variations of the original high-capacity system, each modified to meet the needs of the particular class ship in which installed, and generally referred to in that manner, i.e., CVAs/CVs, LPHs, and LPDs. Regardless of the class ship, they are practically identical in all respects except for the number, capacity, and physical location of some of their component parts and the stowage and distribution capabilities of the individual ships. These differences will be noted in the following paragraphs.

Stowage is in reference to the number and capacity of saddle-type stowage tanks installed on the different class carriers. Table 5-1 shows the number and location of tanks on the different class carriers and the total capacity of AvGas carried on each.

A set of saddle-type stowage tanks consists of three interconnected tanks (outer, inner, and drawoff). Except for the tanks on the CVA 41

Table 5-1.—Number, location, and capacity of stowage tanks

Class ship	No. of tanks	Location	Total capacity
CVA 19 & 34 Class		1 set centerline aft	94,000
CVA 41 Class	1	1 set stbd. side aft	62,000
CVA 59 Class	1	1 set stbd. side aft	110,000
CVA 63 Class and up	1	1 set centerline fwd	98,170
LPH 2 Class	2	2 sets forward	220,466
LPD 3 Class	1	1 set centerline aft	97,000

Table 5-2.—Riser sizes, pump capacities, and distribution capabilities

Class ship	Riser size	Pump capacity	Maximum distribution per quadrant
CVA 19	6 inches	675 gpm at 75 psi	1,200 gpm
CVA 34	6 inches	475 gpm at 100 psi	900 gpm
CVA 41 and 42 class	6 inches	675 gpm at 75 psi	1,200 gpm
CVA 59 class	8 inches	1,100 gpm at 80 psi	2,000 gpm
CVA 63 class and up	6 inches	425 gpm at 125 psi	800 gpm
CVA 43	6 inches	425 gpm at 125 psi	800 gpm
LPH 2 class	6 inches	220 gpm at 90 psi	400 gpm
LPD 3 class	5 inches	220 gpm at 90 psi	400 gpm

class *Roosevelt* and *Coral Sea* (which consist of an outer and drawoff tank) they are constructed identically on all ships.

DISTRIBUTION capability is in reference to the number of quadrant distribution risers and the capacity of the aviation gasoline pumps installed on the individual ships.

All CVAs/CVs, LPHs, and LPDs have only a one-quadrant delivery of AvGas—located on the starboard side in the same vicinity (in respect to forward or aft) as their stowage tanks.

There are two aviation gasoline pumps for each quadrant distribution riser. Normally, the size of the quadrant distribution riser is in relation to the capacity of the quadrant, i.e., 6 inches, 1,200 gpm; 8 inches, 2,000 gpm. However, with the introduction of the new high-capacity systems installed on the CVA 63 class and up, and also on the most recently converted carriers, this does not hold true. Table 5-2 shows the size of the quadrant distribution risers, capacity of each pump, and maximum distribution capabilities for each quadrant on the different class ships.

There is one sea-water pump for each aviation gasoline pump installed in the pumproom. The sea-water pumps are used to pressurize the aviation gasoline tanks to force aviation gasoline up to the inlet side of the AvGas pumps with an adequate positive pressure. One sea-water pump must be in operation for each aviation gasoline pump to be used. The capacities of each sea-water pump for the different class ships are listed in table 5-3.

Except for the additional outer tank supply riser for those ships equipped with two sets of stowage tanks, the arrangement of the sea-water piping and valves is similar on all ships regardless of class.

The arrangement of the aviation gasoline piping and valves and component parts such as pumps, pressure regulators, flowmeters, etc., are also practically identical, regardless of the class ship.

The CVA 43 and all CVA 63 class carriers and up have two 800-gpm vertical filters located

Table 5-3.—Sea-water pump capacities

Class ship	Pump capacity
CVA 19 and 34 class	600 gpm at 18 psi
CVA 59 class	1,000 gpm at 20 psi
CVA 63 class and up	400 gpm at 20 psi
CVA 43 conversion	400 gpm at 20 psi
LPH 2 class	200 gpm at 20 psi
LPD 3 class	200 gpm at 20 psi

in the filter room on the 3rd deck level. One filter is designated as "IN-USE" and the other as "STAND-BY." LPDs have two 400-gpm vertical filters located at the pumproom level. The LPHs have one 300-gpm vertical filter installed at each service station. All other CVAs and CVs have one main service filter located in the filter room at the 3rd deck level. Their capacity is in relation to size of the distribution riser on the individual ships, as previously described.

The ABF should have a detailed knowledge of the AvGas system to ensure that the protection designed into the system is not nullified due to improper methods of operation. The safe operation of the system depends on the constant attention to proper operation and maintenance procedures and the observance of safety precautions by each member of the aviation fuels division.

STOWAGE SYSTEMS

On vessels, other than tankers, fitted for bulk stowage of gasoline, there are two types of stowage systems in use. The most widely used is the hydraulic system. The other is the inert gas displacement system. The inert gas displacement system is not discussed in this training manual due to its very limited use. The hydraulic system is used on all aircraft carriers.

The hydraulic stowage tank is designed on the principle of the U-tube. If gasoline is placed in one leg of the U-tube and an equal volume of sea water in the other, their positions will be similar to that shown in figure 5-1A. The hydraulic gasoline system is, in reality, a giant U-tube. The stowage tanks, containing sea water and gasoline, form the bottom of the tube. The sea-water piping forms one side of the tube, and the gasoline piping forms the other side (fig. 5-1B).

A cubic foot of sea water weighs 64.0 pounds, while a cubic foot of gasoline weighs about 45.8 pounds. Since gasoline is not miscible with sea water and is lighter in weight, it will float on sea water and not mix with it.

From the preceding paragraphs, it can be seen that the hydraulic stowage of gasoline is based on two principles:

1. The weight per unit volume of gasoline is less than that of sea water; therefore, gasoline will float on sea water.
2. A given head of sea water in a U-tube will hold in balance a greater head of gasoline.

The gasoline system is designed to keep the tanks completely full of liquid at all times, either with gasoline on top of sea water or else completely full of sea water. (See fig. 5-1 B.)

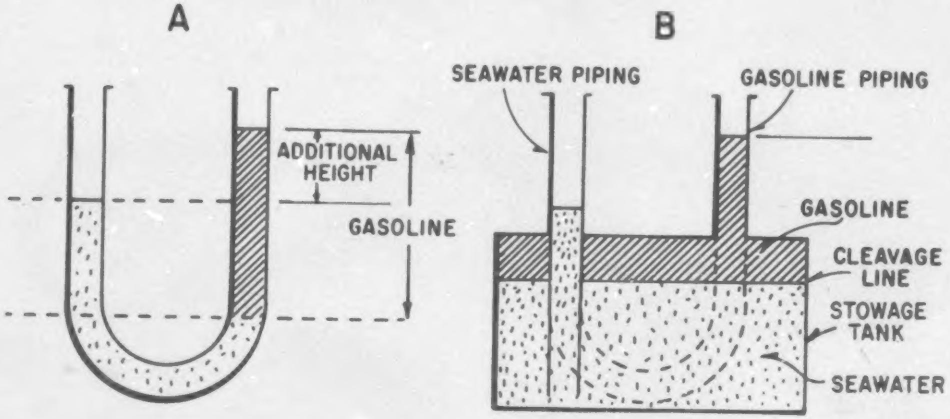

Figure 5-1.—U-tube analogy.

Sea water replaces the gasoline as it is removed from the tanks. In this manner no air pockets holding explosive vapors can form.

STOWAGE TANKS

The saddle-type stowage tanks are designed to provide the greatest possible safety for the stowage of aviation gasoline. They are located inboard on or near the centerline of the ship. The top of the tank is just below the first platform, and the bottom is the hull of the ship.

A set of stowage tanks (fig. 5-2) consists of three tanks–an outer tanks, an inner tank, and a drawoff tank. The outer tank encloses the inner tank, and the inner tank encloses the drawoff tank, for which the aviation gasoline pumps are supplied. The stowage tanks are surrounded by cofferdams filled with nitrogen for protection against fire and explosion hazards.

Outer Tank

The sea water supply riser enters the outer tanks at the top and terminates in a diffuser near the bottom. The sea water required for pressurizing the tanks is discharged through this line.

A pressure gage line extends from the top of the outer tank to a pressure gage located in the pumproom. The gage has a red pointer, indicating the maximum allowable tank-top pressure for that set of tanks. (Allowable pressure will vary for the different class ships.) A warning plate attached near each gage reads: THE MAXIMUM ALLOWABLE TANK-TOP PRESSURE INDICATED BY THE FIXED RED POINTER SHALL NOT BE EXCEEDED WHEN FUELING THE SHIP. The gage is corrected to allow for the difference in height between the tank top and gage.

Two in-tank reservoirs (sump tanks) for Taylor gages are installed in the outer tank. One reservoir is installed at the top of the tank and the other at the bottom directly underneath the upper. Stuffing boxes are provided where the tubing for the Taylor gage passes up through the outer tank. The stuffing boxes prevent leakage of AvGas and sea water out of the tank and nitrogen in the cofferdam from entering the tanks.

The outer tank is interconnected with the inner tank by a sluice pipe. The sluice pipe extends from near the top of the outer tank and terminates in a diffuser at the bottom of the inner. The top of the sluice pipes is flared to reduce friction. The outer tank completely envelopes the inner tank.

Inner Tank

The inner tank has the largest capacity of the three tanks. It also contains two reservoirs and connecting tubing for the Taylor gages. The reservoirs are installed in exactly the same manner as those in the outer tank. The inner tank is interconnected with the drawoff by a sluice pipe. The sluice pipe extends from near the top of the inner tanks and terminates in a diffuser at the bottom of the drawoff. The inner tank completely envelopes the drawoff tank.

Drawoff Tank

The drawoff tank is the smallest of the three tanks. It is the tank from which gasoline is drawn when servicing aircraft, off-loading fuel, etc. It is the first tank to be filled when receiving and the last tank to be emptied when off-loading fuel.

The AvGas supply riser extends from the extreme top of the drawoff tank to the common suction header of the AvGas pump.

The recirculating header terminates in a diffuser at midpoint in the drawoff tank.

The drawoff tank is provided with an independent stripping system to remove water and sludge from the bottom of the tank. This system is of the same hand-operated type used with the JP-5 service tanks and has the same rated capacity (30 gpm at 50 double strokes per minute). The suction line is fitted with a shutoff valve and extends from three-fourths of an inch off the bottom of the tank. The discharge line, fitted with a bull's eye sight glass gage, test connection, one-way check valve, and a shutoff valve, terminates in a diffuser between the top and midpoint of the outer tank.

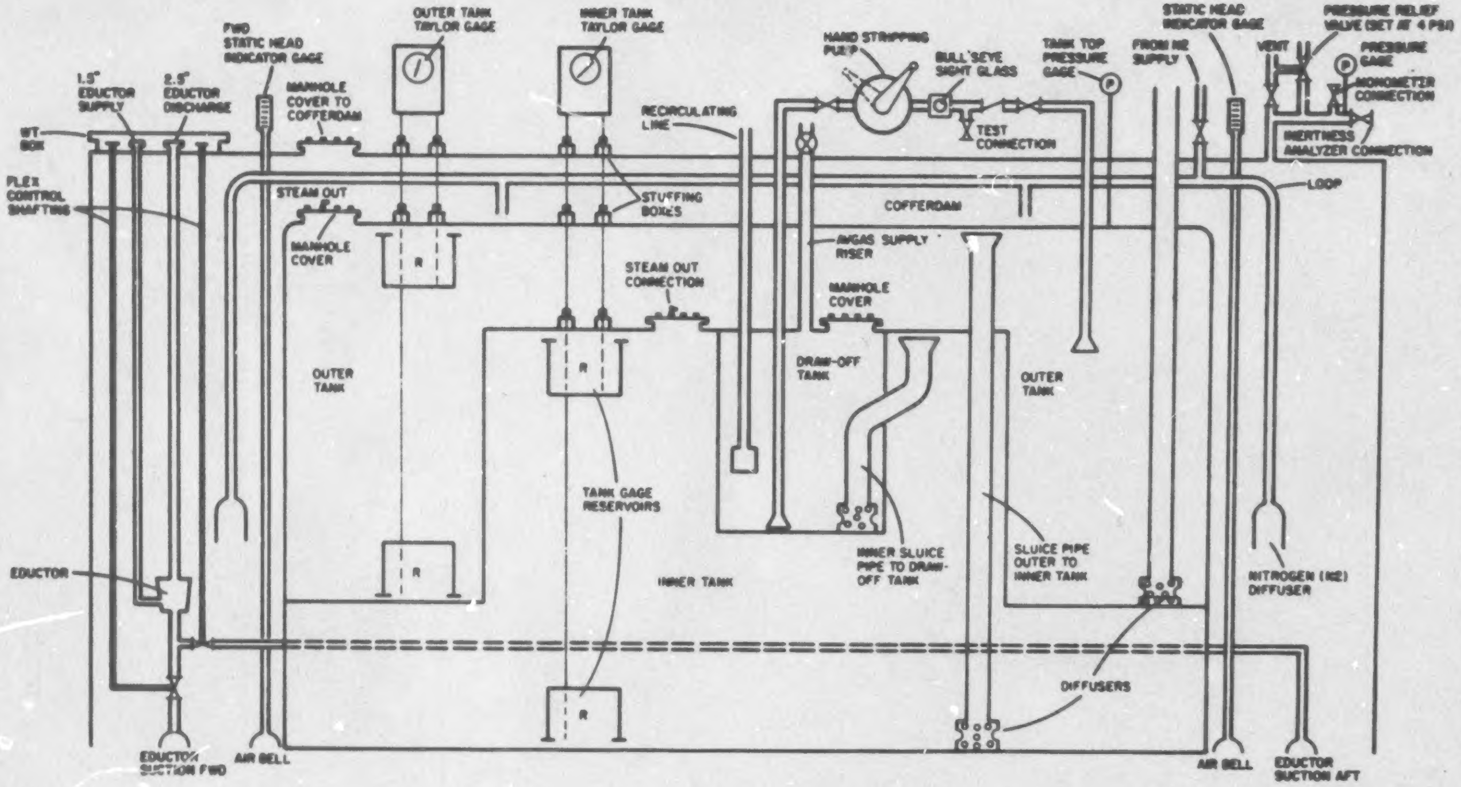
1.5" EDUCTOR SUPPLY
2.5" EDUCTOR DISCHARGE
FWD STATIC HEAD INDICATOR GAGE
MANHOLE COVER TO COFFERDAM
OUTER TANK TAYLOR GAGE
INNER TANK TAYLOR GAGE
RECIRCULATING LINE
HAND STRIPPING PUMP
BULL'S EYE SIGHT GLASS
TEST CONNECTION
TANK TOP PRESSURE GAGE
FROM N2 SUPPLY
STATIC HEAD INDICATOR GAGE
VENT
PRESSURE RELIEF VALVE (SET AT 4 PSI)
PRESSURE GAGE
P
MONOMETER CONNECTION
INERTNESS ANALYZER CONNECTION
LOOP
WT BOX
FLEX CONTROL SHAFTING
STEAM OUT
MANHOLE COVER
STUFFING BOXES
COFFERDAM
AVGAS SUPPLY RISER
STEAM OUT CONNECTION
MANHOLE COVER
R
OUTER TANK
DRAW-OFF TANK
OUTER TANK
TANK GAGE RESERVOIRS
INNER SLUICE PIPE TO DRAW-OFF TANK
SLUICE PIPE OUTER TO INNER TANK
NITROGEN (N2) DIFFUSER
EDUCTOR
INNER TANK
DIFFUSERS
EDUCTOR SUCTION FWD
AIR BELL
AIR BELL
EDUCTOR SUCTION AFT

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Figure 5-2.—Aviation gasoline stowage tanks.

COFFERDAMS

The tanks are surrounded on the top, ends, and sides by two cofferdams, one port and one starboard.

The cofferdams provide a two-fold protection for the stowage tanks. Cofferdams are normally kept charged with nitrogen (N_2) gas to 1/2 psi at 50-percent inertness to reduce fire and explosion hazards. They also serve as a void space to collect any leakage from the stowage tanks.

The nitrogen supply line for purging and charging cofferdams terminates in a loop which completely encircles the outer tank. From this loop (located near the top of the cofferdam) pipes (legs) extend down to near the bottom. Each leg is fitted with a diffuser which serves to spread the gas throughout the space. A stop valve for controlling the nitrogen entering the cofferdam is located in the main supply line at the pumproom level.

Oxygen is a necessity to support combustion. Normal air contains 21-percent oxygen by volume. There must be 15-percent oxygen by volume to support combustion of a hydrocarbon vapor (AvGas). Other types of fuel may require more or less oxygen. Some fuels do not require any outside oxygen to burn, for example, gunpowder.

The inert gas (nitrogen, CO_2, etc.) displaces the oxygen in the cofferdam. Percent inertness is a measurement of the amount of oxygen in the air in the cofferdam.

In figuring percent inertness, 21-percent oxygen in the air represents 0 percent inertness, and no oxygen in the air represents 100-percent inertness.

The following formula may be used to figure the percent of oxygen (O_2) in the air when the percent inertness (PI) is known.

$$\text{Percent } O_2 = 21.0 - \frac{21.0 \times PI}{100}$$

The following formula may be used to figure the percent inertness (PI) when the percent of oxygen (O_2) in the air is known.

$$PI = \frac{21.0 - O_2}{21.0} \times 100$$

A vent fitted with a shutoff valve, extends from the top of the cofferdam and vents to the atmosphere. A bypass line is installed around the shutoff valve. This line contains a pressure relief valve (set at 4 psi), a manometer connection, pressure gage, and a portable inertness analyzer connection.

The nitrogen for inerting the cofferdams is obtained from the O_2N_2 producer plant as a byproduct in the manufacture of liquid oxygen. This nitrogen is piped to the AvGas pumprooms through a reducing panel where its pressure is reduced to 15 psi. Suitable piping and valves are located in the pumproom to control the charging of the cofferdams. A vent system of piping is installed to vent the tanks during the charging. This vent system leads over the side of the ship and is not tied into any other vent system on the ship. Relief valves set at 4 psi are installed in the vent system to relieve any overpressure in the cofferdam.

When charging the cofferdams, the vent valves are opened in the vent system, and the nitrogen introduced into the cofferdam forces the oxygen containing air out the vents. Since the nitrogen is lighter than air, the inlet is located at the cofferdam top and the vent pipe near the bottom. The venting of the cofferdams should continue until a minimum 50-percent inertness reading on a portable inertness analyzer is obtained. Detailed coverage on the operation and maintenance of the portable inertness analyzer is found in chapter 9 of this training manual.

When the required reading has been obtained, the vents should be closed and the pressure in the cofferdam allowed to build up to 1/2 psi.

Connections are provided so that CO_2 may be used to inert the cofferdam when nitrogen is not available. The same procedure of venting and introducing nitrogen is used for CO_2. Care must be taken to limit the rate that the CO_2 is released from the cylinders to prevent the valves and connections from freezing due to the expansion of the CO_2 as it leaves the cylinder. Where it is possible to do so, the CO_2 cylinder may be inverted to help prevent the freezing condition. Since CO_2 is heavier than air and the inlet and outlet in the cofferdam are arranged for nitrogen (lighter than air), the introduction of the CO_2 must be at a slower rate than for nitrogen to prevent the loss of the CO_2 through the vent pipe.

Due to its chemical characteristics, less CO_2 is needed to provide adequate protection in the cofferdams. When using CO_2 in the cofferdams, 35-percent inertness is the minimum reading required on the portable inertness analyzer.

Four static-head type liquid-level gages are installed in the cofferdams to indicate the presence of leakage into the compartments. One gage is fitted on the starboard side and one on the portside about the ship's centerline at the forward end of the cofferdams, and one gage is fitted on the starboard side and one on the portside about the ship's centerline at the after end of the cofferdams so that any liquid present in the cofferdams will be indicated regardless of the trim of the ship. The gages are of the King Engineering Corporation type with the indicators and the hand pumps located in the gasoline pumproom.

The gages are calibrated to read in gallons of AvGas having a specific gravity of 0.72 and are designed to indicate the presence of small quantities of liquid. Any water that may be present in the cofferdam may also be indicated by these gages. Water, which has a specific gravity of 1, will cause the gage to indicate a greater amount than is actually present.

To operate the gage, operate the hand pump on the body of the indicating unit until the red column of liquid stops rising. Then read the volume of liquid in the tank from the scale.

A water jet eductor is installed in each cofferdam to remove any sea water or AvGas which might leak into the cofferdams.

Access to the cofferdam is gained through a bolted manhole cover in the pumproom deck. Normally the cofferdam manhole cover is located directly over the outer tank manhole cover.

The operating gear for the eductor suction valves and the connections for the actuating water and eductor discharge are located in watertight boxes in the gasoline pumproom. The boxes have bolted covers and are kept closed. Actuating water is provided by a hose connection from the fire main, and the discharge is led overboard through a hose valve in the sea-water overflow loop.

Fixed Eductor

A fixed eductor is installed in each cofferdam to remove any sea water or aviation gasoline that might escape from the stowage tanks. The eductor is fitted with two suctions, one near the centerline at the forward end of the cofferdam and the other near the centerline at the after end of the cofferdam.

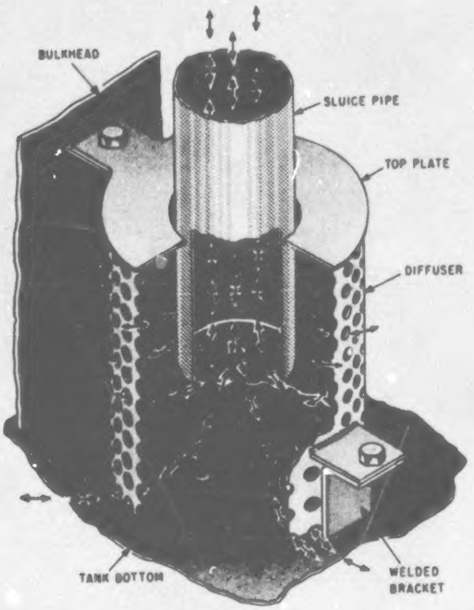
NOTE: Only one of the two suctions should be used at any one time. (See NAVSHIPSINST 9480.68A for principles and operation of fixed eductor systems.)

The controls for the eductor are located in a watertight box on the pumproom deck.

DIFFUSER FOR AVIATION GASOLINE STOWAGE TANKS

The diffuser reduces turbulence when aviation gasoline or sea water enters the stowage tanks. Diffusers are mounted on the bottoms of the aviation gasoline stowage tanks around the end of each sluice pipe and sea-water supply riser. They are bolted to clips or brackets welded to the bottoms of the tanks and to the bulkheads. (See fig. 5-3.)

The diffuser is a perforated cylinder with an open bottom and has a top plate with an opening for the aviation gasoline or sea water supply pipe. The opening in the top plate is larger than the outside diameter of the supply pipe, permitting the pipe to move with the movement of the ship's structure. The total area of the perforations in the diffuser is five times that of the area of the supply pipe. Aviation gasoline or water enters the diffuser in a single stream and is broken into smaller streams as it passes through the holes in the cylinder. The distribution of flow over a large area reduces turbulence.



197.20

Figure 5-3.—Diffuser for AvGas stowage tanks.

OPERATION

When the gasoline system is in operation, the independent sea-water system exerts pressure on the liquid in the outer tank. This pressure is transmitted in turn to the inner tank and drawoff tank through the sluice pipes. In this manner, gasoline is displaced from the drawoff tank and delivered to the gasoline pumps in the pumproom under a positive pressure.

Gasoline vaporizes readily and, unless a positive system pressure is maintained on the suction side of the gasoline service pumps, the pumps tend to become vapor bound. During topside fueling operations, the independent sea-water system pressure must be provided before the gasoline can be delivered.

As gasoline is pumped from the drawoff tank, it is replaced with gasoline from the inner tank; and this gasoline, in turn, is replaced by gasoline or sea water from the outer tank. (See fig. 5-4A.) The gasoline or sea water withdrawn from the outer tank is replaced by sea water from the sea-water system. After all gasoline has been withdrawn from the outer tank, a protective layer of sea water surrounds the inner tank and drawoff tank which still contain gasoline. (See fig. 5-4 B.)

When gasoline is being received or being put into tanks, the flow through the tanks is reversed.

On ships having four sets of tanks, two sets are located forward and two sets aft. Where there are more than one set of tanks, two sets are joined together with the outer and inner tanks having a common bulkhead along the centerline of the ship. See figure 5-5 for this type of arrangement.

CVA/CV GASOLINE SYSTEM

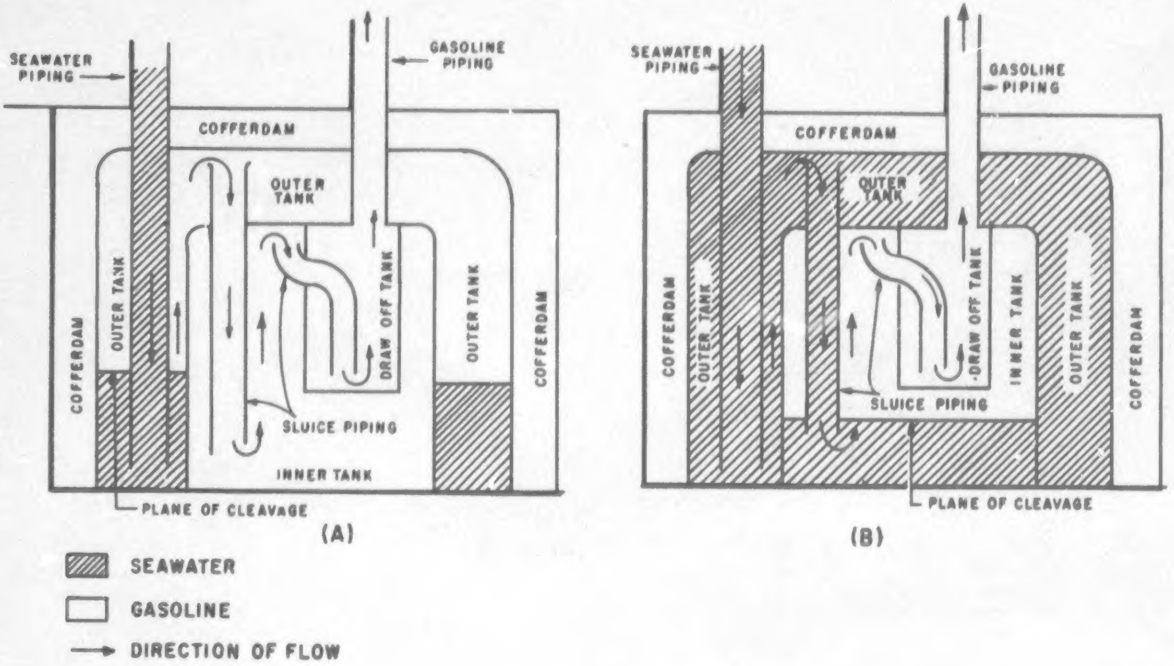
The gasoline system described here is a typical system for the CVA/CV class carrier. Components may differ from ship to ship, but serve the same function in each system.

GENERAL DESCRIPTION

The gasoline stowage tank is located below the first platform in the after section of the ship and is arranged about the ship's centerline. On some CVAs/CVs the stowage tank may be located in the forward section of the ship. The tank consists of three tanks, as has been previously explained. Each of these tanks has a manhole at its top for access.

A sea-water system is provided which delivers sea water to the stowage tank to displace gasoline removed and keep the tank full of liquid at all times, above zero gage pressure.

Sea-water pumps associated with the system discharge to the outer tank through a line fitted with an overflow loop. The size and height of this loop prevent the sea-water pressure from exceeding the tank test head (pressure) when the gasoline system is in a static condition and both sea-water pumps are in operation. The capacity of the sea-water pump is sufficient to maintain a positive pressure at the AvGas service pumps when the AvGas system is at its maximum delivery rate.


SEAWATER PIPING
GASOLINE PIPING
COFFERDAM
OUTER TANK
OUTER TANK
OUTER TANK
DRAW OFF TANK
COFFERDAM
COFFERDAM
SLUICE PIPING
INNER TANK
PLANE OF CLEAVAGE
(A)
SEAWATER PIPING
GASOLINE PIPING
COFFERDAM
OUTER TANK
COFFERDAM
OUTER TANK
DRAW OFF TANK
INNER TANK
OUTER TANK
COFFERDAM
SLUICE PIPING
PLANE OF CLEAVAGE
(B)
▨ SEAWATER
☐ GASOLINE
→ DIRECTION OF FLOW

197.21

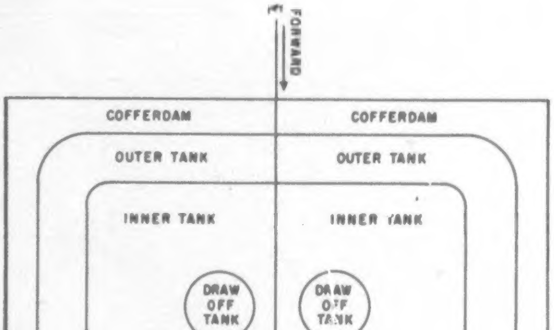
Figure 5-4.—Fluid flow through tanks.

The sea-water pumps and the AvGas service pumps are located in the AvGas pumproom on the first platform above the stowage tanks.

The AvGas service pumps take suction from the top of the innermost tank (drawoff tank) and discharge through a pressure regulating valve, a venturi, and a meter, to a filter on the third deck which removes water and solid matter from the gasoline.

The discharge from the filter is piped in two mains, which run outboard of the shell of the ship, to supply the four AvGas aircraft fueling stations.

At each AvGas fueling station there are two manually operated hose reels, each with 150 feet of 1 1/2-inch noncollapsible hose which is used for fueling and defueling aircraft. The AvGas fueling stations have one pump each, rated at 50 gpm, which is used for defueling only, but is operated during both fueling and defueling operations. The defueling pump discharges to the AvGas fueling station supply. The defueling pump also empties the hoses after the fueling or defueling operation is completed.


FORWARD
COFFERDAM
COFFERDAM
OUTER TANK
OUTER TANK
INNER TANK
INNER TANK
DRAW OFF TANK
DRAW OFF TANK
COMMON CENTER LINE BULKHEAD
PLAN (TOP) VIEW OF TWO SETS OF GASOLINE TANKS.

197.22

Figure 5-5.—Stowage tank arrangement.

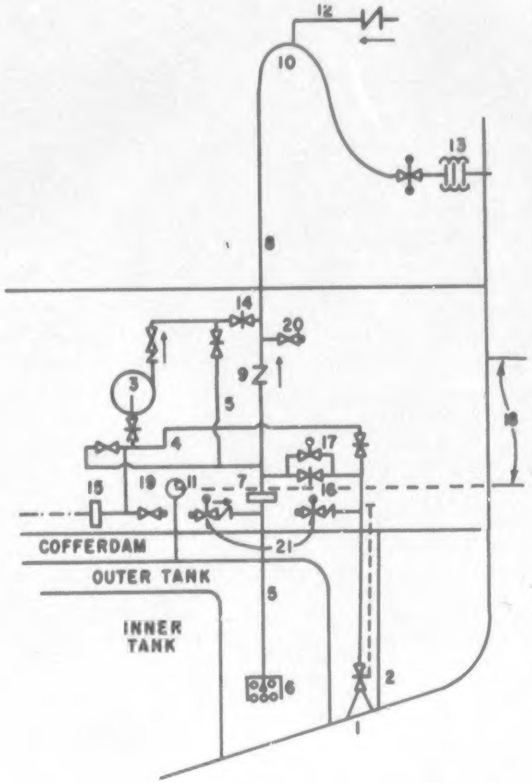
Connections from the ship's nitrogen system have been provided at several locations for inerting the AvGas piping system.

DRAWOFF TANK STRIPPING SYSTEM AND PUMP

A separate stripping system has been provided for the drawoff tank to remove sludge and water from the bottom of the tank. A line 1 1/2 inches in diameter has been led from a point 3/4 inch above the bottom of the drawoff tank to a hand-operated oscillating pump located in the gasoline pumproom. The pump is rated at 30 gpm at 50 double strokes per minute. A stop valve is fitted at the pump suction. A sight flow indicator, test connection, check valve, and stop valve are fitted in the pump discharge line. The stripping pump discharge is piped to the outer tank.

SEA-WATER SYSTEM

An independent sea-water system is provided to supply sea water for displacing the AvGas while it is delivered to the aircraft fuel stations. (See fig. 5-6.)



1. Sea chest.
2. Sea chest valve.
3. Sea water pump.
4. Suction header.
5. Filling line.
6. Diffuser.
7. Spectacle flange.
8. Standpipe.
9. Check valve.
10. Loop.
11. Pressure gage.
12. Vent line.
13. Heating coils.
14. Cross connection.
15. Pipe blind.
16. Cutout valve.
17. Leak-off line.
18. Waterline head.
19. Eductor suction.
20. Discharge.
21. Steam-out connections.

197.23

Figure 5-6.—Sea water system schematic.

Sea-water pumps are connected to a common suction and also to a common discharge header. Pressure from the salt-water pump(s) is placed upon the outer tank and is transmitted through sluice lines to the inner and drawoff tank to the suction header of the AvGas service pumps. This maintains a positive suction pressure on the AvGas service pumps at all rates of flow.

The sea-water system takes suction from a sea chest (1, fig. 5-6) located in the cofferdam around the stowage tank. The operating gear for the sea chest valve is located in a watertight box in the pumproom. This sea chest valve (2) is locked open.

Two motor-driven centrifugal sea-water pumps (3) are provided. The pumps are located in the gasoline pumproom, and the motors are in the adjacent pump motor room. The shaft connecting the pump to its motor passes through an airtight stuffing box in the bulkhead. These stuffing boxes require periodic maintenance.

The two pumps take suction from the suction header (4) supplied by the suction sea chest and discharge into a common discharge header. The discharge header supplies the sea water for the filling line (5) to the outer tank.

The sea-water filling line terminates in a diffuser (6) at the bottom of the outer tank. A diffuser similar in design is also fitted to the lower end of the sluice pipe. Pipe blinds or spectacle flanges (7) are fitted in the filling line and in the sea-water flushing line to provide means for blanking off the pipe when steaming out the tank or when flushing the tank. The pipe blinds are located in the gasoline pumproom.

The sea-water discharge header is connected to a standpipe (8) which discharges overboard. The standpipe is separated from the sea-water filling line by a check valve (9) and is led upward in a loop (10) and then overboard.

The height of the overflow loop acts as a relief device which limits the pressure that can be exerted at the top of the outer tank.

A pressure gage (11) has been fitted in the pumproom to indicate the tank-top pressure for the outer tank. Observe the warning plate reading: "THE MAXIMUM ALLOWABLE TANK-TOP PRESSURE (PSI) INDICATED BY THE FIXED RED POINTER SHALL NOT BE EXCEEDED WHEN FUELING THE SHIP." (The maximum allowable tank-top pressure varies from ship to ship due to the tank design and the size of the piping installed in the sea-water system. The gage is corrected at installation for its height above the tank top, so that the gage indications will be that of tank-top pressure.)

A vent line (12) is taken off the top of the overflow loop, and it runs overboard. The vent line is provided to break the siphoning effect of the overflow loop to prevent lowering the pressure at the AvGas pump suction header. Both the overflow line shell connection and the vent line shell connection are fitted with steam heating coils (13) to keep the lines clear under icing conditions.

A valved cross connection (14) is fitted between the sea water pump discharge header and the overflow pipe so that the sea water pumps can discharge directly overboard through the overflow loop when the pumps are used for flushing or pumping out the stowage tank. This can be accomplished by taking suction with the sea-water pumps from the outer tank and discharging directly overboard through the sea-water overflow loop.

A line fitted with a pipe blind (15) connects the AvGas line from the drawoff tank to the sea-water pump suction header for use when flushing the tank. The blind is normally equipped with a blank gate. The gate is changed to the open gate only for flushing operations.

To provide a source of water for flushing the AvGas tanks, a line is connected between the sea-water sea chest line and the sea-water overflow line for the tank.

The sea line cutout valve (16) is fitted with a 1/2-inch valved bypass leak-off line (17). The 1/2-inch valve is locked open. Since the bypass is locked open, the stowage tank is always open to the sea. Thus the tank will always be kept full and subject to the ship's waterline head (18). The bypass line is to allow for expansion and contraction of the liquids to the stowage tanks. AvGas expands approximately 0.7 percent for each 10° F increase in temperature.

An eductor suction (19) and a discharge (20) are provided for removing pocketed water from the sea water lines before commencing tank steaming operations.

Steam-out connections (21) are provided for steaming operations. Similar connections are provided on the gasoline side of the system.

Sea-Water Pumps

The two sea-water pumps that are located in the AvGas pumproom are electric-motor-driven centrifugal pumps driven by single-speed, explosion-proof motors. The pump shafts pass through a stuffing box secured in the compartment bulkhead, preventing entry of gasoline vapor into the motor room.

On the basis of one sea-water pump for each AvGas service pump, one or two sea-water pumps must be placed in operation to pressurize the AvGas in the stowage tank prior to starting up the main AvGas pumps. This is done to maintain a positive suction pressure on the AvGas pumps at all times during pumping operations. To alleviate the reduction of suction head caused by a negative scoop effect at the sea chest when the ship is turning, the sea-water pump should be started under this condition with the discharge valve closed.

There are several pumps in use at the present time for the pumping of sea water in the CVA gasoline system. Allis-Chalmers pumps are used on carriers of new construction and some of the older carriers. The Weil pump is still in use on some of the older carriers.

ALLIS-CHALMERS SEA-WATER PUMP.–There are two sizes of Allis-Chalmers sea-water pumps. These are designated as the 4 x 4 KSHA and the 6 x 6 SF. The 6 x 6 SF (6-inch suction and 6-inch discharge) is used on CVAs -59, -60, and -61. This pump is rated at 1,000 gpm at a total head of 20 psi. Details on this pump are covered in Technical Manual, NAVSHIPS 347-2559. This pump is similar in most respects, except for size, with the Allis-Chalmers 4 x 4 KSHA.

The Allis-Chalmers 4 x 4 KSHA (fig. 5-7) is used on the latest carriers (e.g., CV-62, -63, -64). This pump is of the double-suction, split-casing, single-stage, horizontal shaft type with the suction and discharge connections in the lower fixed half of the casing. It has a rated capacity of 400 gpm at a total head of 20 psi.

The pump casing is split horizontally at the shaft centerline allowing for ease of inspection and maintenance, as no piping has to be removed from the pump for this purpose. The double-suction impeller (1) is cold-pressed on the shaft (2) and prevented from rotating by a key. Sleeves (3) extending through the stuffing boxes are used to center the impeller. These sleeves are secured by shaft nuts (4). These nuts may be either right- or left-hand thread, according to the rotation of the pump. Wearing rings (6) are heat shrunk onto the suction ends of the impeller. This shaft is supported in ball bearings. These bearings are mounted in a housing (5) supported by brackets cast integrally with the lower casing half. The coupling end bearing is a single-row ball bearing designed to absorb only the radial loads imposed on the shaft. The outboard end bearing is a double-row ball bearing designed to take both the combined thrust and the radial loads imposed on the shaft. The outboard end bearing is secured to the shaft between a shaft shoulder and a locknut. The outer race of both the coupling end and the outboard end is fitted into a housing, and the housing in turn is clamped into place in the bearing bracket. Lubrication for the bearing is provided by a hydraulic fitting in the housing.

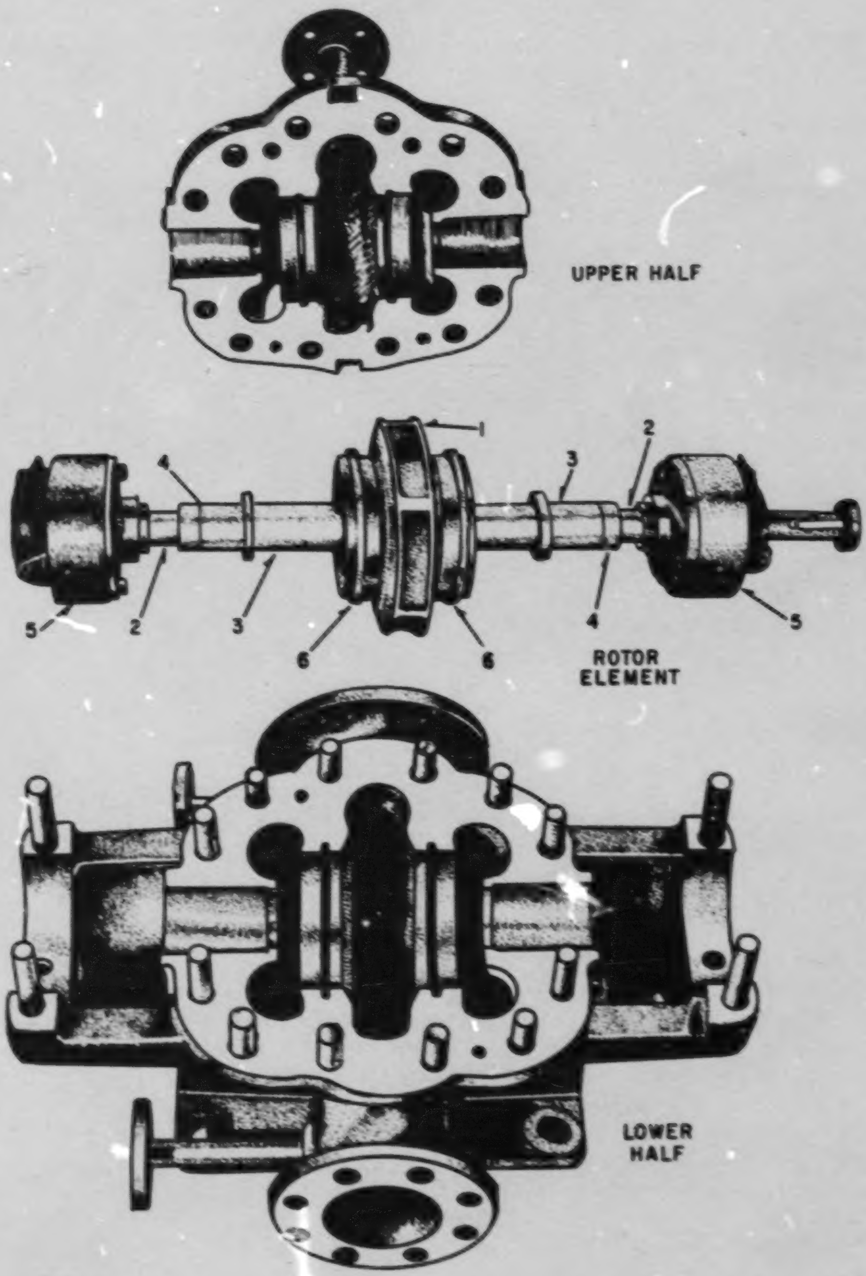
Leakage of water from where the shaft passes through the casing is prevented by stuffing boxes. The stuffing boxes contain five rings each of 3/8-inch square by approximately 9-inch outside diameter semimetallic packing. The packing is retained in the stuffing box on the impeller side by a bushing and on the outside by a split gland. A seal ring is fitted between the second and third ring of the packing. Water is provided to this ring by tubing from a three-way valve on the top casing half (high-pressure side). An O-ring between the shaft and the outer end of the sleeve prevents leakage of water from between them.

The pump is driven through a flexible coupling by an electric motor mounted in an adjacent pump motor room. A stuffing box is provided where the shaft passes through the bulkhead. See NAVSHIPS 347-3426 for additional information on the operation and maintenance of this pump.

WEIL SEA-WATER PUMP.–The Weil pump (fig. 5-8) is a horizontal, centrifugal, single-stage, end (single) suction pump. This is the type KU-5 with a total capacity of 600 gpm at a total head of 18 psi or 41.5 feet.

The pump's single-suction impeller is secured to an extended shaft by a brass locknut. A Woodruff key prevents its rotation on the shaft. Holes are drilled through the impeller to permit the inlet pressure to equalize all around the impeller. This reduces the thrust loads on the impeller and shaft. The shaft is supported in two double-row, single-shield ball bearings. These bearings absorb both the radial and thrust loads developed in the pump.

Lubrication is provided by screwdown grease cups. Leakage of water from where the shaft passes through the pump casing is prevented by a stuffing box. The stuffing box contains four 3/8-inch square by 2 1/8-inch outside diameter rings of asbestos packing. The packing is retained in the stuffing box on the impeller side by a throat ring and on the outside by a split gland and clamp. A seal ring between the first and second ring of packing provides space for water to prevent overheating of the packing and


UPPER HALF
1
2
4
3
3
4
5
2
3
4
5
6
6
ROTOR ELEMENT
LOWER HALF

1. Impeller.
2. Shaft.
3. Sleeve.
4. Shaft nut.
5. Bearing housing.
6. Wearing ring.

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Figure 5-7.—Allis-Chalmers sea water pump, type 4 x 4 KSHA.

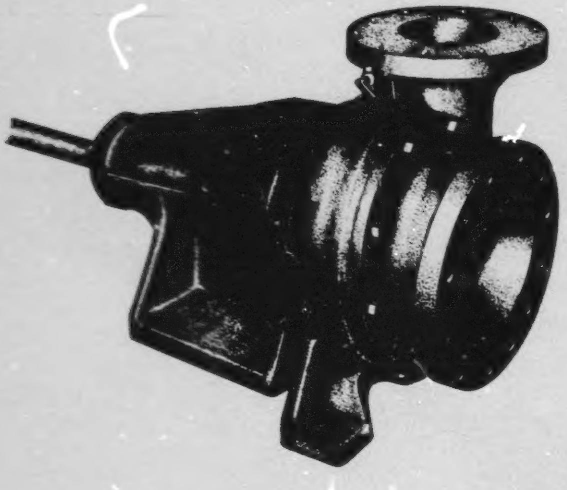

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Figure 5-8.—Weil sea water pump.

shaft. This water is supplied by a copper tube from the discharge side of the pump. A sleeve placed on the shaft where it passes through the packing saves replacement of the shaft due to wear or scoring.

A suction plate is bolted to the casing to serve as the pump inlet and provide access to the impeller. One bronze casing ring is press-fitted into this plate. The casing is in the form of a volute. The volute shape causes the water leaving the impeller to slow and in doing so to increase in pressure. The casing has one of the casing wearing rings press-fitted into it. Wearing rings are also heat shrunk onto the impeller. The wearing rings prevent the higher pressure water on the discharge side of the pump from returning to the inlet. The extended shaft of the pump passes through a bulkhead stuffing box into the pump motor room. A Thomas flexible coupling connects the shaft to an electric motor to drive the pump. (See NAVSHIPS 347-1629 for additional information on the operation and maintenance of this pump.)

CLEAVAGE GAGES

Mutliple step cleavage gages have been provided for the inner and the outer AvGas stowage tanks to indicate the cleavage line between the sea water and the AvGas.

The cleavage gage is acutated by a float and arm transmission unit located in the tank. The combined weight of each float and float arm is such that the float will sink in AvGas but will float in sea water. Therefore, the float will rest at the plane of cleavage between the two liquids.

Multiple step gages consisting of two or three transmission units as shown in figure 5-9 are fitted in the AvGas stowage tanks because the shape and size of the tanks prevent a single transmission unit from indicating the full rise and fall of the cleavage line. The cleavage line will be measured by one of the transmission units while the other floats and arms will be held against their upper stops if they are fully immersed in sea water, or against their lower stops if they are fully immersed in AvGas. Refer to figure 5-9 for the operating diagram of the liquidometer gages.

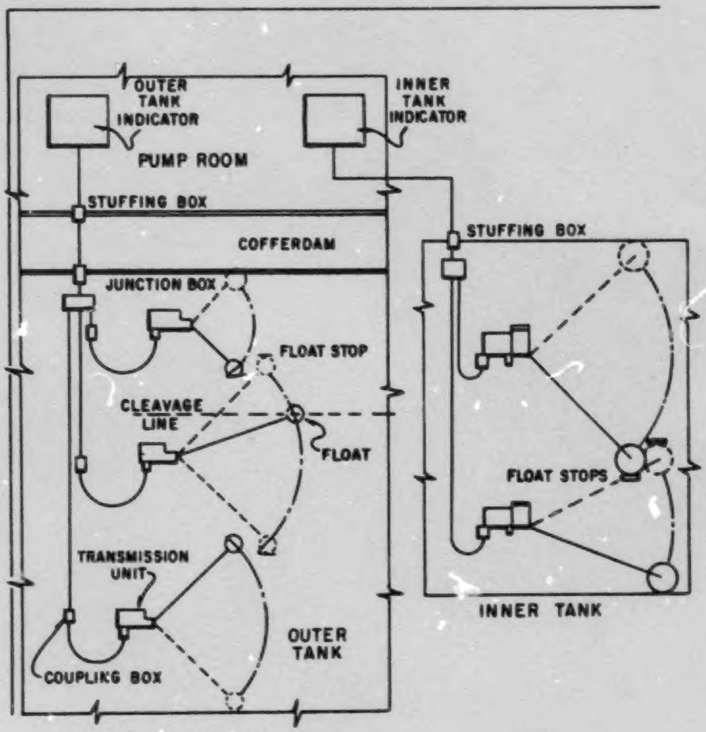
The indicator units for the outer and inner tanks are located in the AvGas pumproom. To ensure a safe working margin, there is still 5 percent of the total gasoline capacity of the stowage tank remaining in the drawoff tank and inner tank when the inner tank indicator dial reads empty. This is necessary, as sea water should never be allowed to enter the drawoff tank during normal pumping operations.

When the outer indicator dial reads FULL, there is sufficient sea water in the outer tank to submerge the bottom end of the sea-water fill pipe in sea water when the ship rolls 25 degrees port or starboard. The full mark on the outer tank indicator dial is 95 percent of the total stowage tank capacity, and should never be exceeded.

The GEMS (TLI) gaging system is slowly replacing the multiple step gaging system and is covered in chapter 6 of this training manual.

AVGAS SERVICE PUMPS

Two motor-driven centrifugal service pumps are provided to serve the AvGas fueling stations on the hangar and flight decks and to discharge AvGas from the ship. The pumps are located in the gasoline pumproom, and the motors are


OUTER TANK INDICATOR
INNER TANK INDICATOR
PUMP ROOM
STUFFING BOX
COFFERDAM
STUFFING BOX
JUNCTION BOX
FLOAT STOP
CLEAVAGE LINE
FLOAT
FLOAT STOPS
TRANSMISSION UNIT
INNER TANK
OUTER TANK
COUPLING BOX

197.26

Figure 5-9.—Cleavage gage operational diagram.

located in the adjacent pump motor room. Each of the two pumps is connected to its motor by a shaft which passes through a watertight stuffing box in the separating bulkhead. These stuffing boxes require periodic maintenance.

A line is taken off the top of the drawoff tank and leads to the suction header for the two AvGas service pumps. The AvGas is forced up to the pump suctions by the sea water in the stowage tanks. The suction header is fitted with a sight glass gage to indicate the presence of AvGas in the piping. The pumps should never be run unless this gage indicates that the suction header is full of AvGas.

The two AvGas service pumps discharge into a common header from which a riser supplies the AvGas fueling station. A recirculating line fitted with a check valve, an orifice, and a stop valve is taken off at the upstream side of each pump discharge cutout valve. This is done so that some AvGas will always pass through the pump when it is running whether or not AvGas is being drawn off at the fueling stations. A check valve on the discharge side of the pump prevents a reverse flow through the pump when the pump is not running.

The recirculating lines from the AvGas pumps combine with the recirculating line located on the downstream side of the pressure regulating valve's venturi. The combined recirculating line is led into the drawoff tank, terminating at the midpoint in the tank.

The pump suction header and discharge header are cross-connected so that the pumps can be bypassed when filling the tanks with AvGas, when defueling aircraft, or when draining the distribution piping back into the stowage tank.

The service pumps for the AvGas system closely resemble the previously described

Allis-Chalmers sea-water pump with the exception of the packing. The packing for these pumps is of the mechanical seal type. (See fig. 5-10.) This figure shows a cutaway view of the various parts of the seal and their relation to each other.

The AvGas service pump in most common use with high-capacity gasoline systems is the Worthington, rated at 675 gpm at a total head of 241 feet, or 470 gpm at 325 feet. The pumps are of the centrifugal-type, with a volute (spiral-shaped) runner casing. The pump impeller is turned by a single-speed, explosion-proof, electric motor.

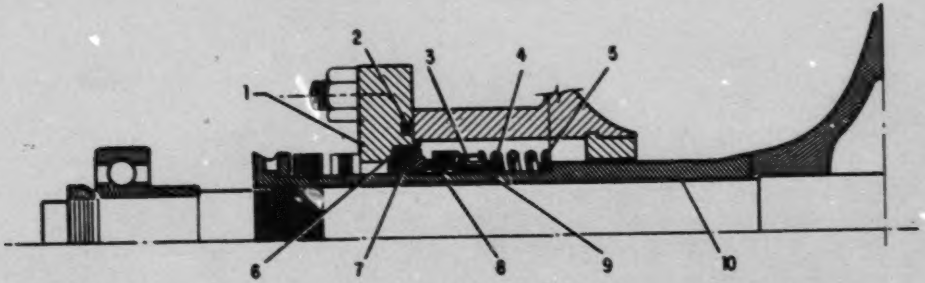
The pumps are designed to operate with a flooded suction. This is accomplished by the sea-water pumps pressurizing the stowage tanks, thereby forcing the AvGas into the pump suction header. The pump is of the double-suction type, so called because AvGas flows to both sides of the impeller at the same time.

The impeller is of the enclosed type. It is keyed to the shaft and is centered in the volute by the shaft sleeves. The shaft sleeves are screwed on the shaft, and are prevented from axial movement by setscrews. Renewable type wearing rings on either side of the impeller minimize recirculation of AvGas from the discharge side of the pump to the suction side.

Leakage of AvGas along the impeller shaft is held to a minimum by two mechanical shaft seals of the bellows type—one on each side of the impeller. The mechanical seal is the most critical component of an AvGas service pump. Once the seals are properly installed, they require no maintenance. However, proper installation of the seal is a must, in order to prevent leaks. The entire seal should be replaced when the pump is open for inspection or whenever a leak occurs. The bellows will not reseat itself after it has been removed from the shaft. No part of the seal can be repaired once it has been damaged. Whenever the seal must be replaced on the pump, consult the applicable pump manual for the proper procedure in installing the seal. For details of the seal see figure 5-10.

The pump shaft is supported by two double-row, oil-lubricated ball bearings—one on each side of the pump casing. Each bearing housing is provided with a constant-level oiler to maintain constant lubrication. A high grade oil having the viscosity characteristics indicated by Navy symbol 2190T should be used as a bearing lubricant. A breather tube is installed on top of each bearing housing to permit escape of oil vapors. Cooling of the bearing housing is effected by a fan located in the fan housing.

Pump and motor shafts are connected by an all-metal flexible, double-engagement, gear-type coupling. A flexible coupling is not a universal joint. The same care should be exercised in alignment of the shafts with flexible couplings as



1. Gland.
2. O-ring.
3. Drive band.
4. Spring.
5. Spring keeper.
6. Seal ring.
7. Floating seat.
8. Carbon ring.
9. Bellows assembly.
10. Shaft sleeve.

197.27

Figure 5-10.—Mechanical seal.

if rigid couplings were used. Two ounces of a good fluid lubricant must be put in the coupling through one of the two holes in the flange before putting the pump in operation. DO NOT USE GREASE. Care must be taken to replace plugs tightly so that oil will not be thrown out of the coupling in operation. Couplings should be inspected periodically to ensure that the proper amount of oil is maintained at all times.

In starting the AvGas pumps, the following procedure should be used:

1. Check oil supply of bearings.
2. Open pump vent, suction, discharge, and recirculating valve and ascertain that there is positive suction head produced by the operation of the sea-water pumps.
3. Start motor.
4. After the pump has started, close the vent valves. Watch pressures and temperatures. Bearings and stuffing boxes should be watched for overheating. Temperatures of stuffing boxes should not exceed 140° F.
5. To secure the pump, stop the motor and close the suction, discharge, and recirculation valves.
6. Cooling of the service pumps is provided by the movement of AvGas through the pump casing during pumping operation. In a standby operating condition, the recirculating line to the drawoff tanks recirculates 25 gpm. According to the pump manufacturer, this condition will not exceed 9° F rise in AvGas temperature. The highest temperature the AvGas tanks are expected to reach is 85° F. With the 9° F rise in temperature through the pumps, the maximum AvGas temperature should not exceed 94° F.

CAUTION: Do not operate the pump at a temperature above 100° F as shown by the thermometer installed on the discharge side of pump. To prevent formation of vapor on the suction side, see that pumps are always supplied with a positive head of AvGas by prior operation of the sea-water pumps. Do not operate pump if the suction pressure gage reading is zero or less.

AUTOMATIC PRESSURE REGULATOR

An automatic pressure regulating system is installed in the riser from the service pump discharge header for the purpose of maintaining a constant pressure between the venturi and distribution system for all rates of flow when fueling aircraft. The pressure regulating valve is controlled by a pilot valve, which responds to pressure variations in the throat of the venturi tube fitted downstream of the regulating valve. (See fig. 5-11.)

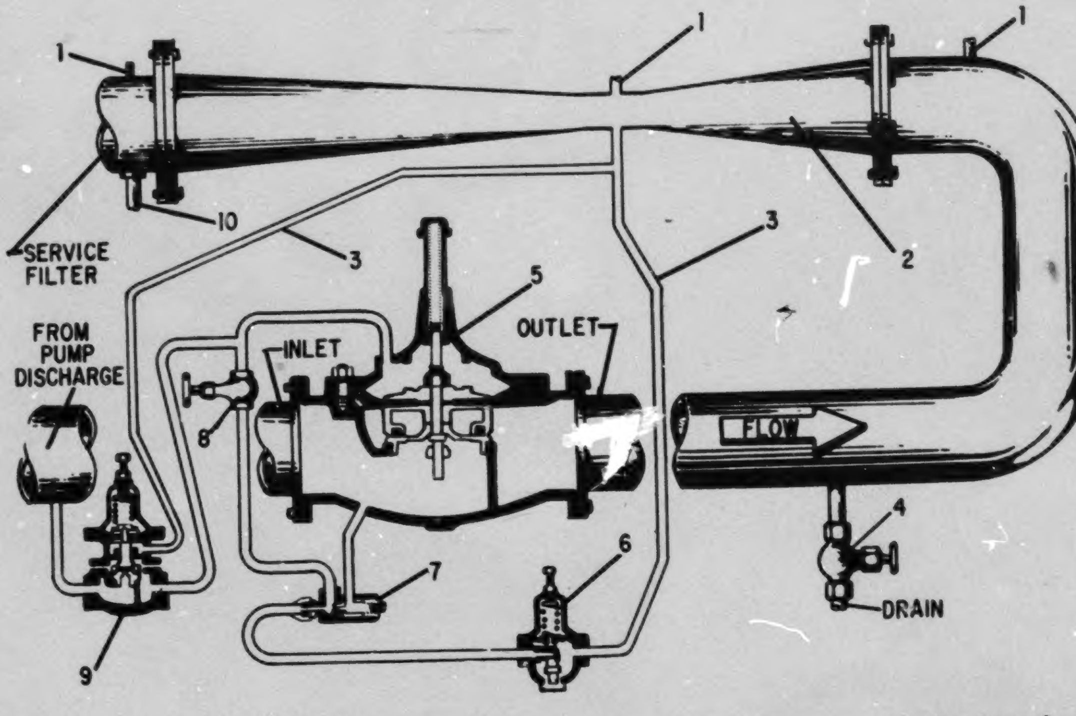
An auxiliary valve has also been fitted to accelerate the closing of the regulating valve in case the flow is suddenly reduced. This valve is called a control valve. The regulating valve, venturi, and associated equipment are located in the gasoline pumproom.

It is the pressure in the throat of the venturi that is used as the actual control pressure for the pressure regulating equipment. A low pressure in the throat of the venturi will allow the loading pressure in the regulating valve to dump and the regulating valve will tend to open, increasing the flow. An increase in pressure in the throat of the venturi will decrease the rate of dumping of the loading pressure in the regulating valve and the regulating valve will tend to close, decreasing the flow. An excessively high pressure in the throat of the venturi will cause the control valve to open and load the regulating valve with full line pressure, causing it to close rapidly.

As the filter becomes dirty, the pressures at the filter outlet will drop. It will be necessary to readjust the setting of the pilot and control valve of the automatic pressure regulating system to maintain the desired pressure at the filter outlet until the filter elements are renewed.

A recirculating line is taken off the venturi outlet and connected to the recirculating line from the AvGas service pump discharge. This recirculating line serves as a means of preventing full shutoff of the regulating valve during zero demand. It also serves as a return to the drawoff tanks without realigning the system when draining the fueling hoses.

The pressure regulating equipment is fitted with a bypass for use when filling the tanks with gasoline, when defueling aircraft, or when draining the distribution piping back to the tanks. For additional information, refer to the Technical Manual, NAVSHIPS 348-1159.



1. Gage line.
2. Venturi.
3. Actuating line.
4. Drain valve.
5. Hytrol valve.
6. Pilot valve.
7. Ejector-strainer.
8. Globe valve.
9. Control valve.
10. Recirculating line.

197.28

Figure 5-11.—Pressure regulating system.

POSITIVE STOP VALVES

Positive stop valves are installed throughout the AvGas system. This is a nonlubricated tapered plug-type valve. The body of the valve is made of bronze, and the plug is case steel with a coating of Hycar rubber. The cup and cone stem packing is made of Teflon, and the bonnet gasket is of Buna-N and cork impregnated material. (See fig. 5-12.)

To open the valve, the handwheel is turned in a counterclockwise direction, looking down on the valve. This unseats the plug. During the raising operation, the stem cannot turn as the ratchet is held in place by the ratchet pin. At the limit of upward travel of the stem and plug, further turning of the handwheel in a counterclockwise direction turns the valve plug and ratchet. Each 90 degrees of turn of the handwheel turns the valve alternately from the open to the closed position, and is accompanied by an audible click as the ratchet pin falls in place. The position of the valve plug port is indicated by a large arrow above the handwheel.

After the plug is turned to the open position, as shown by the indicator arrow, it must be seated to place the plug opening in line with the body opening. This is accomplished by turning the handwheel in a clockwise direction until handtight.

CAUTION: The handwheel should never be turned with a wrench or any other lever to seat the plug.

To close the plug, rotate the handwheel counterclockwise, thus raising the plug. Continue the counterclockwise rotation 90 degrees after the plug is fully raised. The indicator arrow will then show the valve closed. Following this, the handwheel is turned in a clockwise direction until handtight.

The Hycar rubber face of the plug will wear with use. Excessive wear will cause improper seating of the plug. The plug should be replaced when the handwheel nut touches the indicator before the wheel is turned handtight.

NOTE: Other valves: i.e., Okadee, Butterfly employed in those AvGas systems are discussed in Chapter 6 of this training manual.

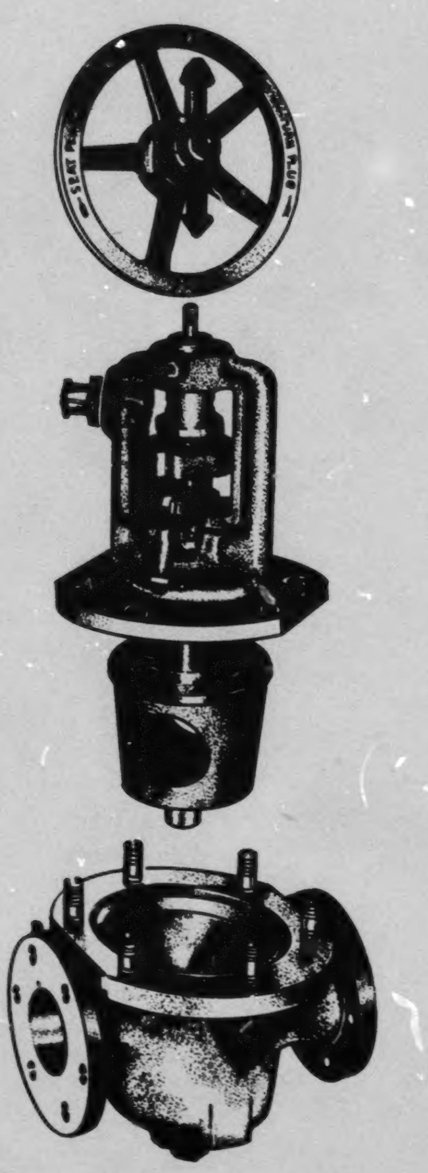


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Figure 5-12.—Positive stop valve.

GASOLINE TRUNKS AND DOUBLE-WALL PIPING

The AvGas riser from the pumproom is led up through the pumproom access trunk to the third deck level, then outboard through a special gasoline trunk to the filter room on the starboard side. The horizontal portion passing through the gasoline trunk is encased in a larger steel pipe forming a double-wall pipe. (See fig. 5-13.)

The outer pipe is inerted with nitrogen gas at 10 psi. The outer pipe also serves to collect any AvGas which may leak from the inner pipe. A drain plug has been provided on the outer pipe to drain any AvGas which has leaked into it. A pressure gage for the double-wall piping is located in either the filter room or AvGas pumproom to indicate the nitrogen pressure in the outer piping. The gage has a range of 0 to 15 psi with a sector from 5 to 10 psi designated as the normal operating range. If the nitrogen pressure in the outer piping deviates from the normal operating range more than 2 psi, secure the AvGas flow to the riser immediately. A drop in pressure indicates a leak from the outer pipe, allowing nitrogen gas to leak out. A rise in pressure indicates a leak into the outer pipe of AvGas from the inner pipe. The outer pipe is fitted with a relief valve to avoid excess pressure. This relief valve is vented to the outside of the ship through separate piping.

AVGAS FILTER/SEPARATOR

There are several different types of filters in use today; however, their principle of operation

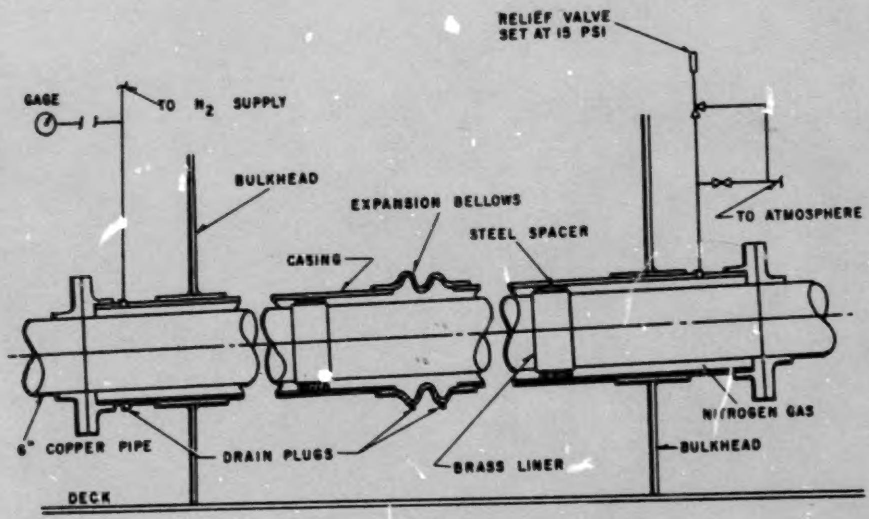

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Figure 5-13.—Section of double-wall piping.

and hydraulic controls are similar. Some filters are horizontal, and others are vertical; however, the only major difference is their physical shape and rated capacity. Regardless of this fact, all filters are designed to perform identical functions and in practically the same manner. In this chapter we will deal only with the vertically mounted filter. (See fig. 5-14.)

Basically the filter/separator is a two-stage unit. The first stage consists of coalescing elements used for filtering the solids from the fuel and coalescing water into large droplets; the second stage consists of separator elements used for separating any remaining water and solids from the fuel.

Contaminated fuel under pressure enters the unit through the inlet pipe and flows upward into and through the coalescing elements, which filter all solid contaminants and coalesce water into large droplets. The water settles out into the fallout section and is automatically discharged from the unit through a water drain valve. The fuel rises and passes through the separator elements, which remove any remaining water and solids. The clean fuel is then discharged from the unit through the outlet and fuel discharge valve at the top of the unit. Both the water drain valve and the fuel discharge valve are controlled by a float control valve.

Description

The unit has a cylindrically shaped, welded, copper nickel shell, with dome shaped heads welded at each end for uniform flow of fuel, and two bolted manholes on the side for replacing the coalescer and separator elements.

Located on the outside is a sight gage, used to determine the water level within the unit, and a differential gage, which determines the pressure drop passing through the coalescer elements. (The rate at which the pressure drop increases is governed by the collection of solid contaminants.) The outlet pressure gage is used to determine the pressure of the decontaminated fuel as it leaves the unit. A fuel discharge valve controls the flow of fuel from the unit.

The interior of the shell is divided into three chambers—the INLET chamber at the bottom is connected to the FALL-OUT chamber through the coalescer elements; the FALL-OUT chamber connects to the OUTLET chamber through the separator elements. A water drain line from the fall-out chamber passes through the inlet

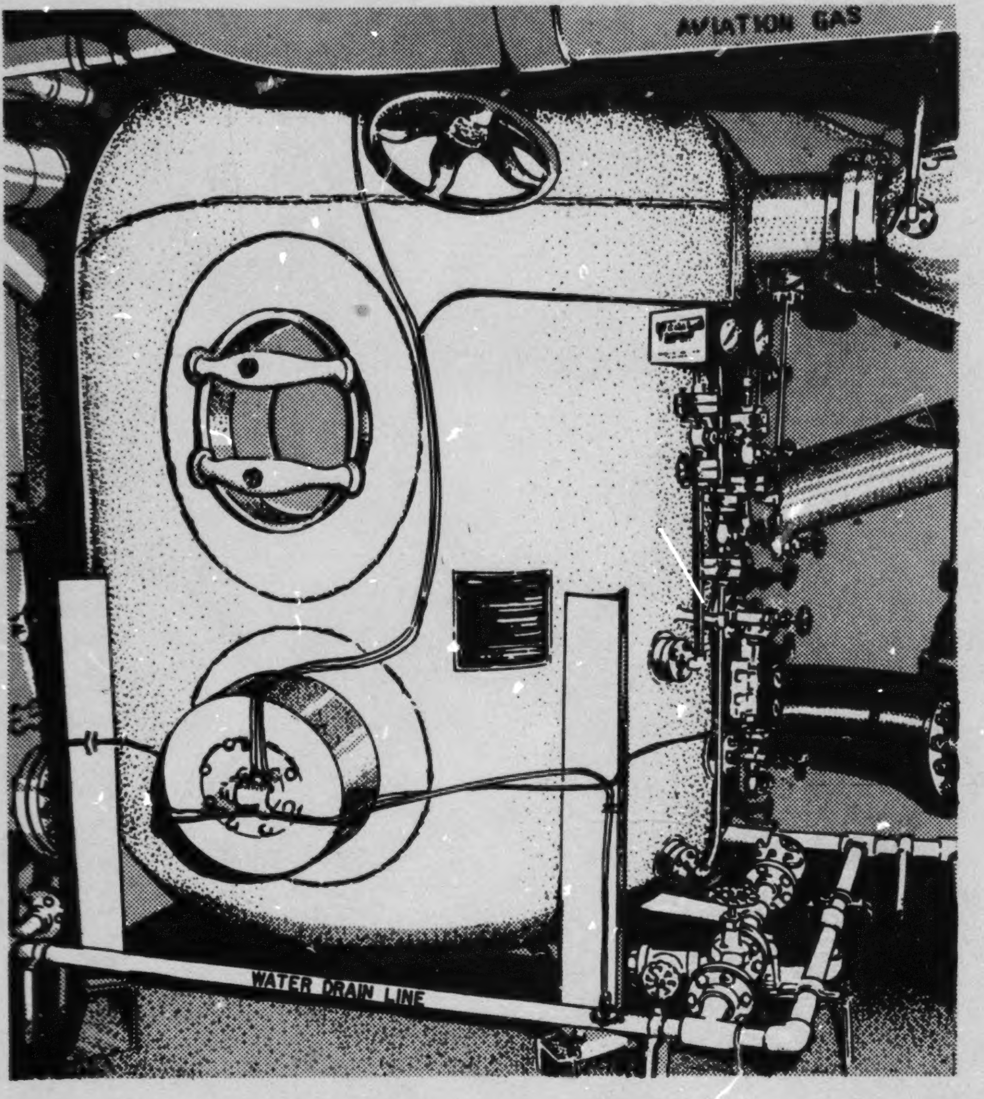

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Figure 5-14.—Vertically mounted filter/separator.

chamber and connects to the water drain system. A float control valve is bolted to the unit near the bottom and is actuated by a captivated float that rises and falls with the water level within the fallout chamber. The captivated float and float control valve control the action of the water drain valve and the fuel discharge valve.

Filter/Separator Operation

Contaminated fuel enters the unit through the inlet pipe and chamber and flows upward and through the coalescer elements. The coalescer elements remove the solid contaminants (98 percent) from the fuel, and coalesce the entrained water (100 percent) into large droplets, which fall to the bottom of the unit in the fall-out chamber (fig. 5-15). (The flow through the coalescer elements is from inside to outside direction.) As the water accumulates, its level causes the captivated float to rise. (The captivated float is designed to float in water and sink in fuel.) The position of the float opens or closes ports in the float control valve, which is connected to both the water drain valve and the fuel discharge valve.

When the float is in the down position, the fuel discharge valve is open and the water drain valve is closed.

When the float is in the horizontal position, the fuel discharge valve and the water drain valve are open, permitting "settled out" water to drain from the filter while clean fuel is passed with uninterrupted flow into the fuel system.

When the float is in the raised position, the fuel discharge valve is closed and the water drain valve is open.

The fuel then flows vertically to the separator elements whose function is to remove the final traces of coalesced water which have not sunk by their own weight into the fall-out chamber. (The flow through the separator elements is from the outside to the inside.)

The fuel, free of contamination and water, then flows out of the filter/separator through the fuel discharge valve into the fuel system piping.

Inspection and Tests for Automatic Water Drain Controls

The following information is provided for guidance in the inspection and test of water drain controls:

1. The filter/separator automatic water drain and slug control valve derive their operating pressures from the pressure of the fuel

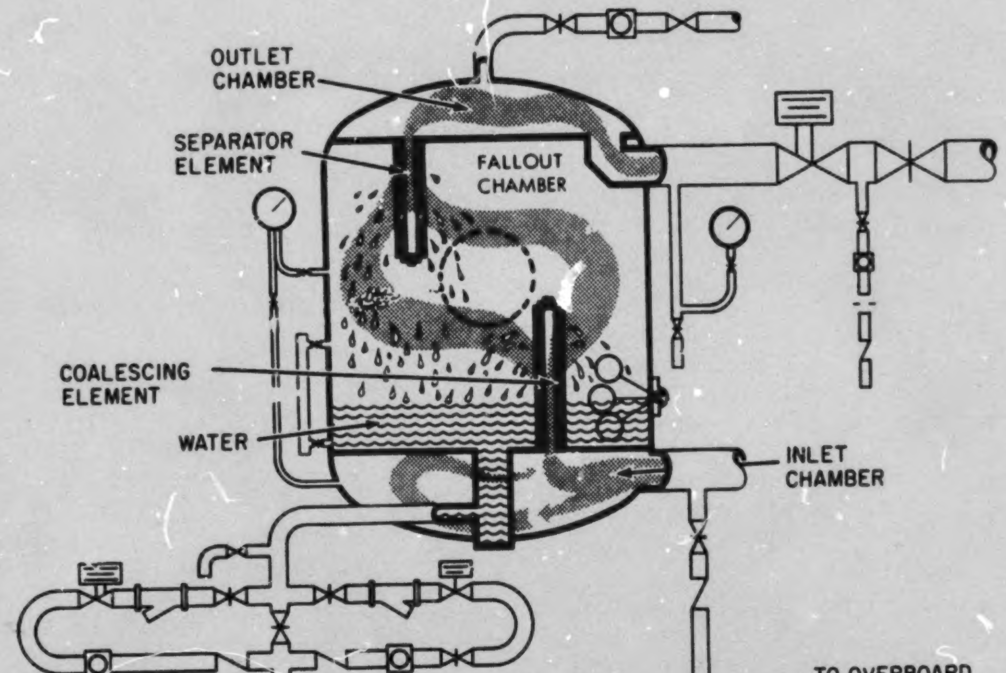

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Figure 5-15.—Fuel flow through filter/separator.

within the filter case. If the actuating line strainer becomes clogged with solids, it is possible to discharge fuel through the drain and/or pump water through the filter/separator. This strainer, if internal to the filter/separator case, should be cleaned when the case is opened for element replacement. Where the strainer is mounted externally to the filter/separator case, it should be checked at the same time as the controls are checked. These controls should be checked for proper operation monthly. The only known means of checking their operation is to actually introduce clean sea water into the filter/separator and observe the opening of the automatic water drain valve and the closing of the slug control valve at the filter/separator discharge.

2. The water may be introduced through any connection to the filter/separator sump. If the filter/separator has a flanged pressure gage line connection at the filter inlet, this location is recommended. Fit a tee to the flange, reconnect the gage line to one branch, and attach a valve and hose connection to the other branch.

3. With the filter/separator in operation, reduce the inlet pressure (AvGas) by throttling to at least 25 psi below the available water pressure. Attach a water hose and slowly add clean sea water until automatic water drain valve opens or the water level reaches the top of the water sump gage glass. If the drain valve fails to open, secure the filter/separator and determine the cause. If the drain valve operates properly, adjust the water flow rate so that the drain valve opens about once a minute. Continue testing for at least 5 minutes. Take samples of fuel from the filter/separator fuel discharge in glass containers and observe their appearance. If the fuel is cloudy or visible water is present, the coalescer elements should be replaced and separator elements tested and replaced if defective or if dirty.

4. Without changing the water flow rate, manually close off the water drain line so that no water can drain from the sump. If the automatic slug control valve at the filter/separator discharge does not close within 3 minutes, or if water level passes the top of the water sump gage glass, secure the filter/separator and determine the cause.

OUTBOARD DISTRIBUTION PIPING

The AvGas distribution lines leaving the filter/separator room are piped outboard through the shell of the ship to supply the aircraft fueling stations. These distribution lines are independent and have no cross connections to any other line. Blister void and double-wall piping on the discharge side of the filter/separator must be inerted the same as the double-wall piping previously described. All AvGas piping that runs outside of the ship below the main deck and in other exposed locations is protected by a nontight U-shaped plating guard.

Risers lead from the distribution main to the individual fueling stations. Normally, each of these risers has a plug-type cutout valve located at the main deck level to isolate the station when necessary.

A valved vent is provided at the extreme ends of the distribution piping for use in venting the inert gas from the piping when filling with AvGas. A length of 1 1/2-inch rubber hose fitted with a nozzle is provided for each vent connection to allow the displaced gasoline to be directed into a safety can. Plug-type cutout valves are provided in the filter room to segregate sections of the distribution system.

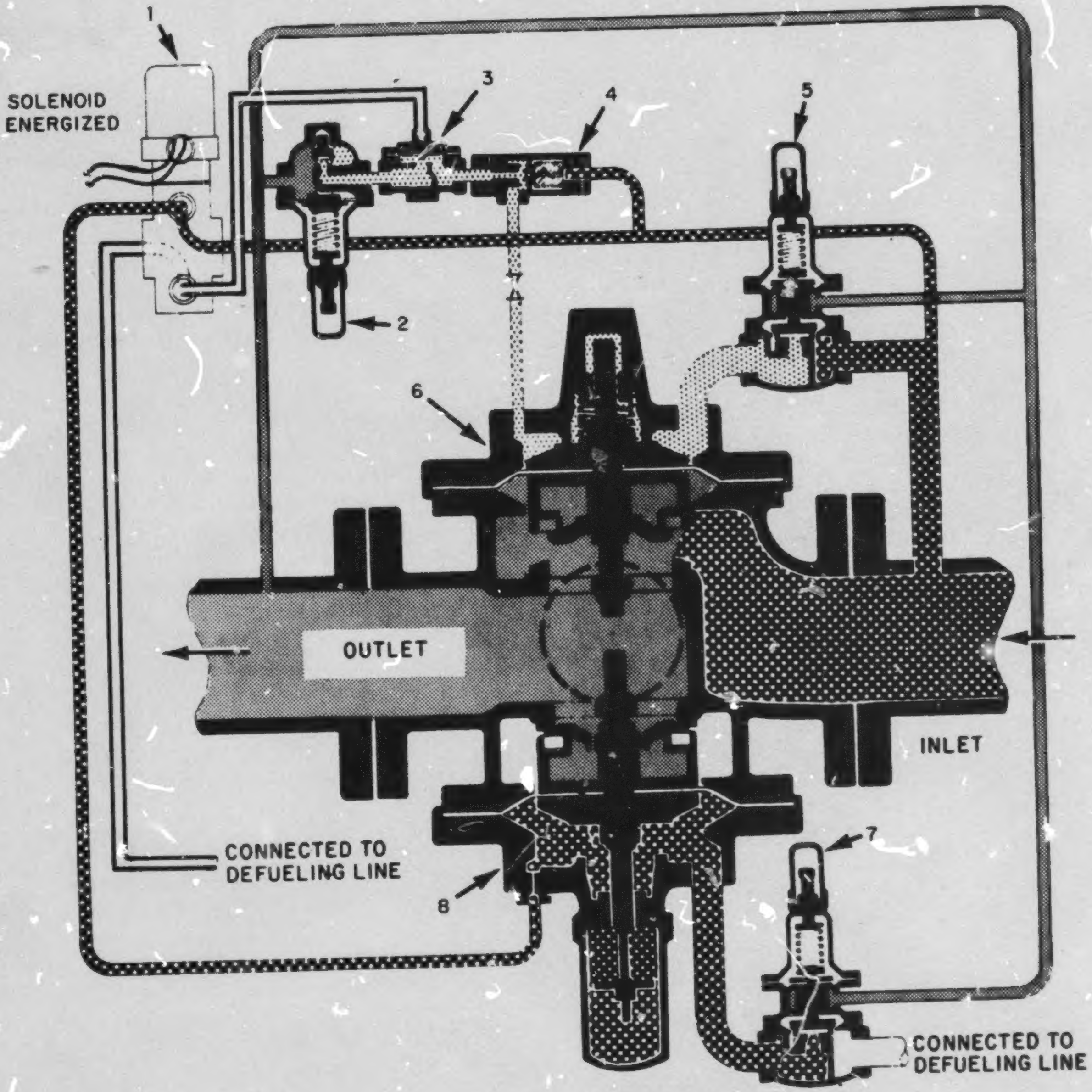
AIRCRAFT FUELING STATIONS

AvGas fueling stations are located on the hangar deck and on the walkways below the flight deck. These locations and the lengths of hose provided allow aircraft to be fueled at any place on both decks.

A riser from the distribution main supplies AvGas to each AvGas fueling station. Each riser terminates at a cutout valve adjacent to the aircraft fueling station.

Three types of aircraft fueling stations are in service aboard CVA/CV-type carriers. Two of these are the Blackmer fueling station and the Wheeler fueling station. These two stations are in use on some of the older CVAs.

All CVAs of new construction and some of the older CVAs have a fueling station that makes use of an automatic fueling and defueling valve. (See fig. 5-16.) This valve is manufactured by the Cla-Val Co.


1
SOLENOID
ENERGIZED
3
4
5
2
6
OUTLET
INLET
CONNECTED TO
DEFUELING LINE
8
7
CONNECTED TO
DEFUELING LINE

1. ASCO solenoid pilot valve.
2. Pressure reducing pilot valve.
3. Hytrol valve.
4. Ejector-strainer.
5. Pressure relief control valve (for fueling valve).
6. Fueling valve.
7. Pressure relief control valve (for defueling valve).
8. Defueling valve.

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Figure 5-16.–Cla-Val fueling station (fueling position).

Fueling stations may have one or two hose reels, each with a three-port two-way diaphragm-operated valve, controlled by a solenoid-operated pilot valve between the station supply riser and the hose reels. The hose reels are of the manually operated type equipped with a length of 1 1/2-inch noncollapsible hose. Each fueling station has one motor-driven defueling pump (explosion-proof type).

The two-way valves are installed to permit the fueling of aircraft or to pump fuel from an aircraft back to a stowage tank (defueling operation). The defueling operation is also used to empty the hose after completion of a fueling operation. The valves are so arranged that they are in the defueling position when the solenoid valve is deenergized. When the solenoid valve is energized and there is pressure in the AvGas supply riser, the valve will open to fuel the aircraft. The solenoid on the valve is energized from the 440-volt motor control circuit through a magnetic amplifier which permits the flow of current to the solenoid as long as the low-voltage circuit through the fueling hose to ground is complete. When the ground connection is broken or the switch on the nozzle valve is placed in the OFF position, the low-voltage circuit is broken, the solenoid is deenergized, and the two-way valve will revert to the defueling position. The magnetic amplifier eliminates the possibility of sparks when the low-voltage control circuit is interrupted.

Automatic Fueling and Defueling Valve

The automatic fuel and defuel valve (fig. 5-16) is designed to perform the following four distinct functions:

1. As a pressure reducing valve to maintain a constant discharge pressure.
2. As a solenoid-operated emergency shutoff valve.
3. As a pressure relief valve whenever discharge pressure rises above a predetermined setting.
4. As a defueling valve to evacuate the piping system beyond the valve discharge.

To perform the functions listed above, two valves are fabricated into one body. During normal fueling operation, the defueling valve (8) is closed and functions as a pressure relief. During defueling operation, the fueling valve (6) is closed and the defueling valve (8) is open. During the fueling operation, the defueling valve opens to serve as a pressure relief valve whenever the pressure on the downstream side rises above the setting of the pressure relief control valve (7).

When the solenoid pilot valve (1) is deenergized, the fueling valve (6) closes to provide positive shutoff of the fueling line and simultaneously the defueling valve opens.

The main valve consists of two single-seated globe valves built into a single body. Each globe valve employs a well-supported and reinforced diaphragm as its operating means. The fueling valve is spring-loaded to close and is therefore normally closed. The defueling valve is inverted and opens due to its own weight; therefore, it is normally open. In the event of diaphragm failure, the fueling valve closes driptight and the defueling valve opens wide.

The pressure relief control valve system utilizes line pressure to control the main valve, thus providing fully automatic operation. When line pressure is admitted to the valve cover chamber, the force thus developed closes the valve. When pressure in the cover chamber is released, line pressure at the valve seat forces the valve open. The pressure relief control valves (5, 7) automatically open to permit flow whenever the controlling pressure under the diaphragm exceeds the force of the compression spring. It was designed primarily as a pilot valve to control the operation of diaphragm-type valves; thus it operates within very close pressure limits.

This is a direct-acting, spring-loaded valve, designed with a large diaphragm working area in relation to the valve seat area to ensure positive operation. It is held closed by the force of the compression spring. Pressure adjustment is made by rotating the adjusting screw to vary spring compression on the diaphragm. Compressing this spring can be adjusted to provide a relief setting from 20 to 70 psi. The adjusting screw is protected by a bronze housing drilled to accommodate a lead seal wire.

The pressure relief control valves (5, 7) are normally held closed by the force of the compression spring. When the controlling pressure under the diaphragm exceeds the set spring force, the disc is lifted off the seat, permitting flow.

The pressure reducing pilot valve (2) automatically reduces higher initial pressure to a steady reduced pressure. It was designed primarily as a pilot valve to control the operation of diaphragm type main valves; thus it operates within very close pressure limits. It is a direct-acting, spring-loaded valve, designed with a large diaphragm working area in relation to the valve seat, which ensures sensitive control and accurate regulation of the delivery pressure. Pressure adjustment is made by rotating the adjusting screw to vary spring compression on the diaphragm. Compressing this spring increases the delivery pressure setting. The spring can be adjusted to provide delivery from 15 to 100 psi. The adjusting screw is protected by a bronze housing drilled to accommodate a lead seal wire.

The pressure reducing pilot valve (2) is normally held open by the force of the compression spring. When the delivery pressure acting upon the lower side of the diaphragm exceeds the force of the compression spring, the valve closes. Conversely, when the delivery pressure reduces below the spring setting, the valve opens. Thus, a constant delivery pressure is maintained by balancing delivery pressure against spring pressure. The valve can be easily regulated by turning the adjusting screw which provides a simple means of pressure adjustment.

The Hytrol valve (3) has a modified globe design, employing a well-supported and reinforced diaphragm as the operating means. When line pressure is admitted to the cover chamber, the force thus developed closes the valve. When pressure in the cover chamber is released, the line pressure at the valve seat forces the valve to a wide open position.

The ejector-strainer (4) consists of a primary and a secondary jet screwed into a cast bronze housing. The jets are protected from clogging by a 60-mesh monel screen. Both jets can be removed for cleaning. Flow through the ejector-strainer (4) creates a reduced pressure area between the primary and secondary jets.

The ASCO solenoid pilot valve (1) is a direct-acting, piston-type, solenoid-actuated valve. The piston is drawn upward by the action of the solenoid when energized, and is returned to the DOWN position under the influence of gravity and a spring when the solenoid is deenergized. The valve discs on the piston are lapped into the bore in the valve body. This valve has full pipe size port areas, and the piston moves from full flow in one direction to full flow in the opposite direction. There is no closed port position. The valve is also equipped with a manual operator. Manual operation is accomplished by pushing upward on the bottom at the lower end of the control. A quarter turn clockwise locks the manual operator in place.

NOTE: For detailed instructions on operation and maintenance, refer to NAVSHIPS Technical Manual, 348-1351.

Defueling Pump

The defueling pump for the AvGas Cla-Val fueling station is of the Blackmer type which has a rotary, positive displacement type pump, utilizing sliding nonmetallic vanes running in an eccentric cylinder. The pump has a rated capacity of 50 gpm at a discharge pressure of 75 psi. Leakage of gasoline from where the pump shaft passes through the pump body is prevented by a mechanical seal similar to those used in the main service pumps. The pump is driven by a 5-hp, 440-volt ac electric motor through a geared speed reducer.

Telltale drain holes are provided under each of the pump bearings to serve as an indication of any leakage of gasoline past the mechanical seals. Excessive leakage at these drain holes is an indication that the seals should be replaced.

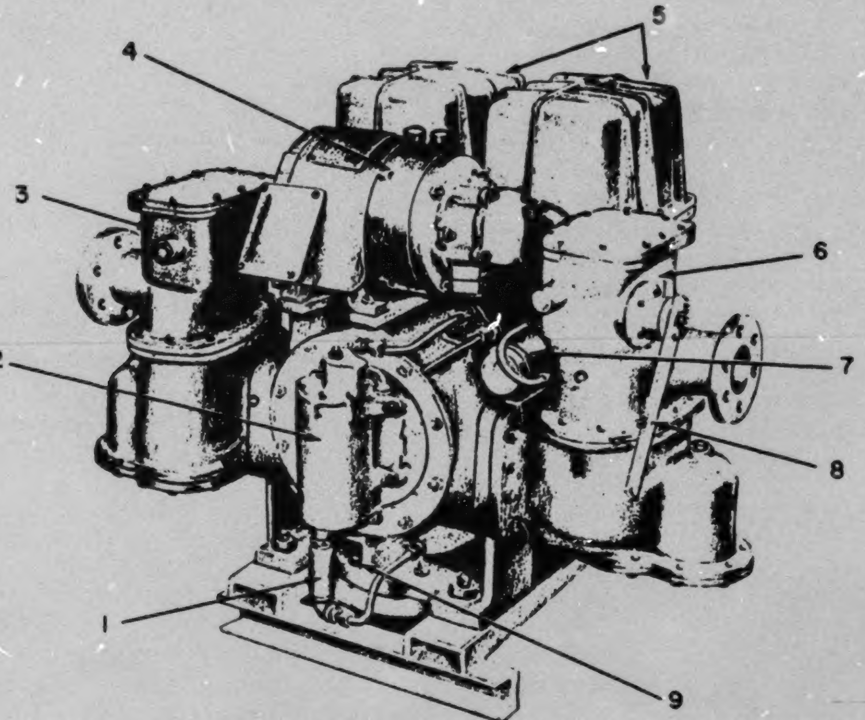
A pressure relief control valve is provided to prevent the building up of excessive pressures which might damage the pump or associated equipment. This valve permits the gasoline to flow from the discharge port to the suction side of the pump, should excessive pressures ooccur.

The discharge line from the defueling pump is led back into the supply riser for the AvGas station. Because of this, the pressure regulating equipment previously described was installed in the AvGas pumproom. This pressure regulator must be set to deliver AvGas to the station at a pressure lower than the discharge pressure of the defueling pump to permit the pump to operate efficiently.

Blackmer Aircraft Fueling Station

Each aircraft fueling station consists of two pumps (in a single housing) driven by a single electric motor, two hose reels containing 150 feet of hose each, and the necessary controllers and pushbuttons for starting and stopping the motors. (See fig. 5-17.)

Each pump on the aircraft service unit is equipped with a semiautomatic four-way valve. This valve is located at the outlet of a flow controller and is connected to the pump suction. The porting of the valve is such that the supply suction line and the discharge line can be reversed at will. Thus, each unit is capable of taking fuel from the supply main and discharging to the hose in the fueling operation; or by reversal, it is possible to create a suction



1. Poppet check valve.
2. Air eliminator.
3. Four-way valve.
4. Priming pump.
5. Magnetic amplifiers.
6. Four-way valve.
7. Control valve.
8. Four-way valve operating handle.
9. Drain plug.

NOTE: Items 1, 2, 4, and 7 have been removed from JP-5 stations ONLY.

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Figure 5-17.—Blackmer aircraft fueling station.

on the hose, thereby pumping the fuel from the hose to the main. Each four-way valve is equipped with a hand-operated lever for placing the valve in the fueling position, and this position is maintained by means of an electrically controlled latch. It is possible to place the unit in defueling or evacuating position by tripping this latch manually, by using a control switch located at either the hose nozzle or the magnetic amplifier case, by improper ground, or by breaking the ground connection to the tank being fueled.

The pump will always stop with the four-way valve in a defueling position. Stopping the pump from a previous operation deenergizes the solenoid holding the latch mechanism.

In the starting operation, any vapor in the pump is evacuated by a vapor eliminator built into the pump. This vapor eliminator is instrumental in evacuating all vapors from the hose when the four-way valve is in the defueling position and the hose nozzle closed. The hose will be completely evacuated of vapors when the normal pump discharge gage reads 20 inches of mercury vacuum or better.

The overwing fueling rate for each pump is about 75 gpm with the 1 1/2-inch hose and about 100 gpm with 2 1/2-inch hose. The defueling rate is about 35 gpm overwing, using the 1 1/2-inch hard hose, and about 25 gpm using the 2 1/2-inch collapsible hose.

The underwing fueling rate for each pump with 2 1/2-inch nozzle is about 150 gpm and the defueling rate about 100 gpm.

NOTE: For detailed instructions on operation and maintenance, refer to NAVSHIPS Technical Manual, 347-1721.

Wheeler Aircraft Fueling Station

The Wheeler fueling station is shown in figure 5-18. This station consists of two centrifugal pumps (7), driven by a single electrical motor, two semiautomatic four-way valves and solenoid assemblies (7), two float-operated priming valves (5), and a priming pump (2) driven by a separate electrical motor (3).

The centrifugal pumps are bolted directly to each end of the main motor. The impellers, casings, and four-way valves are opposite handed. Mechanical seals are provided to prevent leakage of fuel from the casing into the motor and motor bearings.

The priming pump (2) and priming valves (5) work in conjunction to remove nitrogen, air, or vapors from the suction chambers of the fueling pumps. This action also assists in collapsing the hose. The priming pump removes the vapors and gases by suction through the priming valves, and discharges them through the vent piping to atmosphere.

The fuel supply riser terminates at a 4-inch valve. A line leads from this valve to each four-way valve for each pump. This valve acts much in the same manner as the four-way valve in the Blackmer fueling station.

When a fueling operation is completed, it is only necessary to turn off the toggle switch at the fueling nozzle to place the four-way valve in the defueling position. This returns the fuel left in the hose to the system. For detailed instructions on operation and maintenance, refer to NAVSHIPS Technical Manual, 347-3049.

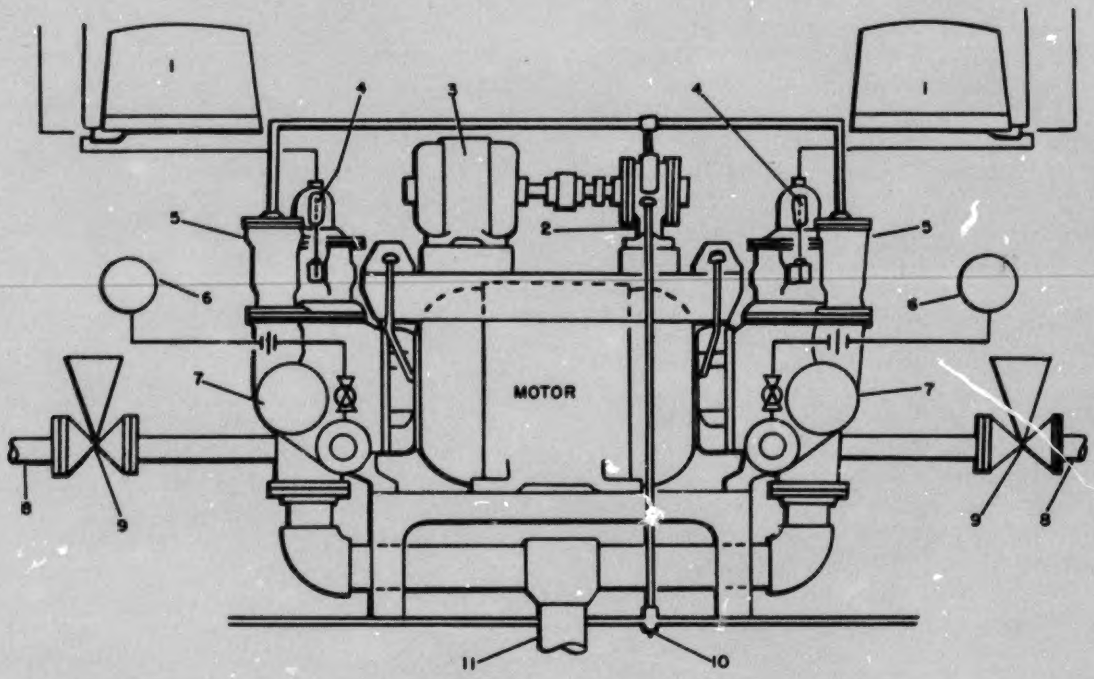
FILLING CONNECTIONS

CVA/CV-type aircraft carriers may have either one or two AvGas filling connections located on the starboard side of the ship.

These connections are used to receive AvGas aboard the ship and to deliver AvGas to other ships. The AvGas receiving system is designed to receive approximately 100,000 gallons of AvGas per hour.

The gasoline must be delivered to the main deck station by the tanker at a pressure of about 44 psi in order to force the sea water out of the stowage tank through the overflow loop.

The AvGas system's sea-water suction must be closed during the receiving operation in order to force the displaced sea water up through the standpipe and overboard to the surface of the sea. Sea water from the tank must never be discharged overboard through the suction piping because there is a possibility of AvGas finding its way to the firefighting sea suction at the bottom of the ship.



1. Magnetic amplifier.
2. Priming pump.
3. Priming pump motor.
4. Operating handle.
5. Priming valve.
6. Compound gage.
7. Fueling pump and four-way valve.
8. Connection to hose reel.
9. Cutout valve.
10. Atmospheric vent.
11. Supply riser.

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Figure 5-18.—Wheeler aircraft fueling station.

The filling connection is fitted with a sliding gate valve at the main deck and terminates in an elbow. The elbow is fitted with a connection, a low-pressure air connection, a thermometer connection, a gage connection, a vent, and a blank flange. The blank flange is removed, and a quick disconnect coupling is installed in its place when receiving AvGas from a tanker. The filling connections are fitted with a vent line leading to the flight deck level, terminating in a plug-type valve and hose connection similar to those for venting the fueling station risers. This vent is used to vent and fill the filling lines with AvGas prior to receiving AvGas.

The AvGas received through the filling connection is led to the stowage tank, through a fill line which connects to the service main in the filter/separator room, bypassing the filters. The service main has bypasses for the pressure regulating equipment and the AvGas pumps in the pumproom. These bypasses are to be used when filling the stowage tank and when draining the system. When pumping from the stowage tank to the main deck filling connections to supply other ships, the AvGas pumps are used.

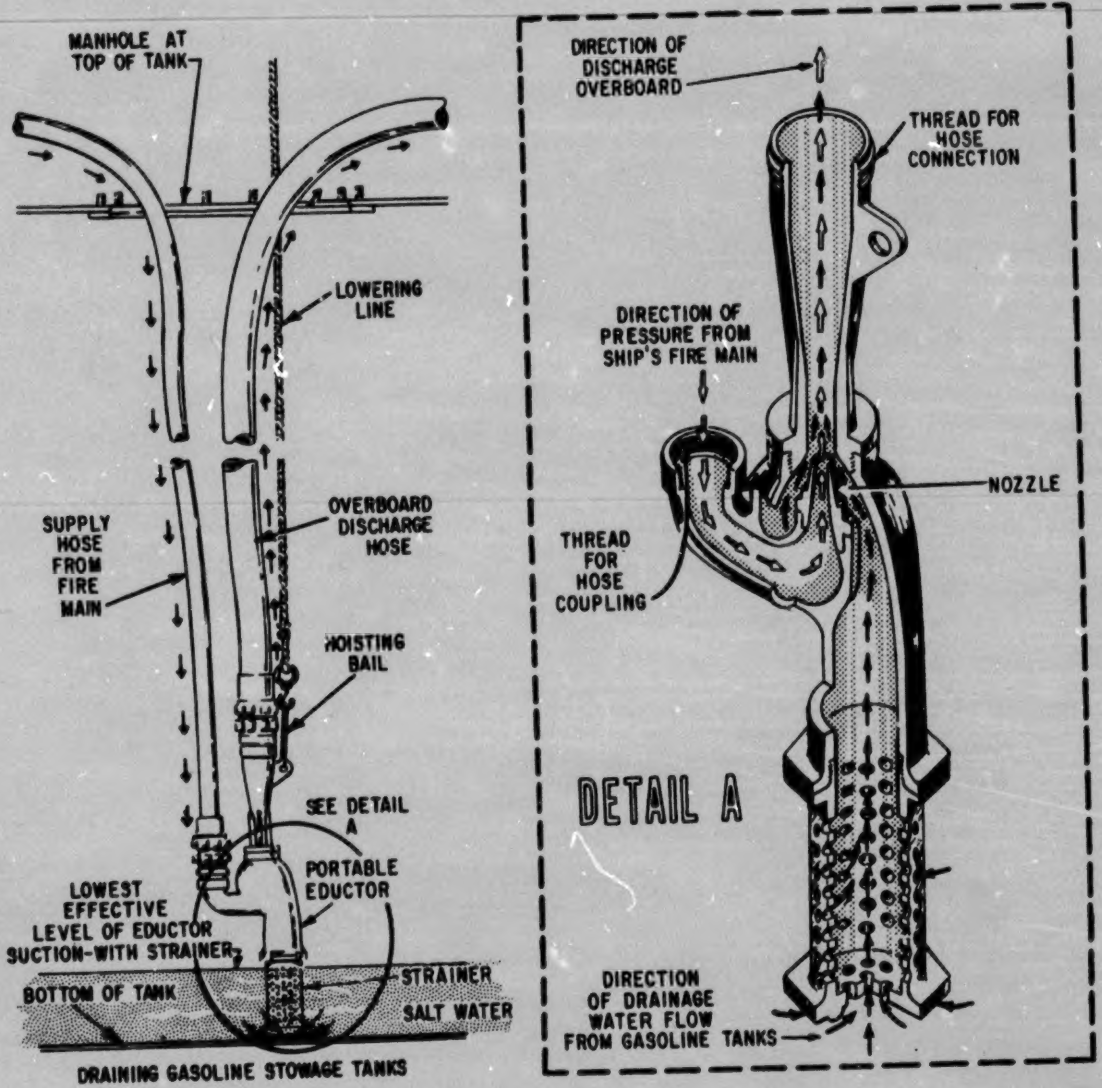
The AvGas filling connection is independent of the outboard distribution system, and AvGas is to be received and delivered through this connection only.

Portable Eductor

Portable eductors are used to provide drainage for aviation fuel pumprooms, to drain the sea water flushing lines prior to rotating the spectacle flanges, to remove condensate from piping during steaming out, and to drain the stowage tanks of the sea water that cannot be removed by the pumps. (See fig. 5-19.)

When not in use, the eductors are stowed as specified by the damage control officer.

The principle and procedure of operation of the portable eductor are similar to those of the cofferdam fixed eductor. The 1 1/2-inch supply inlet on the eductor is connected to a 1 1/2-inch firehose. The other end of the hose is connected to the hose valve on the fire main in the pumproom.


MANHOLE AT TOP OF TANK
LOWERING LINE
SUPPLY HOSE FROM FIRE MAIN
OVERBOARD DISCHARGE HOSE
HOISTING BAIL
SEE DETAIL A
PORTABLE EDUCTOR
LOWEST EFFECTIVE LEVEL OF EDUCTOR SUCTION-WITH STRAINER
STRAINER
BOTTOM OF TANK
SALT WATER
DRAINING GASOLINE STOWAGE TANKS
DIRECTION OF DISCHARGE OVERBOARD
THREAD FOR HOSE CONNECTION
DIRECTION OF PRESSURE FROM SHIP'S FIRE MAIN
NOZZLE
THREAD FOR HOSE COUPLING
DETAIL A
DIRECTION OF DRAINAGE WATER FLOW FROM GASOLINE TANKS

197.34

Figure 5-19.—Portable eductor.

One end of the 2 1/2-inch hose is connected to the tail of the eductor; the other end of this hose is connected to the hose valve on the sea-water overboard discharge pipe, also in the pumproom.

LPH GASOLINE SYSTEMS

There are two gasoline systems on some LPH type ships—the AvGas system and the Auto-Gas system.

AVGAS SYSTEM

This system provides stowage, fueling and defueling facilities, with a maximum of safety, for piston-type helicopters and turbine-powered helicopters utilizing AvGas as fuel.

There are two AvGas stowage tanks located side by side in the forward section of the ship. The principle of operation for these tanks is the same as described previously in this chapter. A single stripping system is installed to remove any sea water and/or sediment from either drawoff tank. The hand-operated stripping pump is rated at 30 gpm at 50 strokes per minute. This pump takes suction from the bottom of the drawoff tank and discharges into the outer tank. A sight glass gage is installed on the discharge side of the pump for visually checking the pump discharge. A sampling connection is also installed on the discharge side of the pump for the drawing of samples. Before starting the sea-water or AvGas pump, the drawoff tank should be stripped of all sea water and sediment and a sample taken to verify that none is present in the drawoff tank.

The cofferdams surrounding the AvGas and AutoGas stowage tanks are equipped with a fixed eductor system for drainage. The valves for these eductors are operated by reach rods located in the pumproom.

When AvGas is taken aboard, the AvGas pumps, the sea-water pumps, and a high-point vent connection are used to prepare the system for filling by eliminating air, vapor, or inert gas in the system. The AvGas pumps and the sea-water pumps must be shut down after the air, vapor, or inert gas in the system has been eliminated.

AvGas must be delivered to the ship at sufficient pressure to permit the filling system to force the sea water in the bottom of the AvGas stowage tanks overboard through the sea-water overboard discharge line.

The AvGas stowage tanks are equipped with a water-filled, static-head, liquid-level gaging system. A flowmeter equipped with a totalizer is installed to measure flow in either direction.

The AvGas in the AvGas tanks is floated on top of sea water to prevent air or vapor accumulation in the tanks. The AvGas tanks consist of an outer stowage tank, inner stowage tank, and a drawoff tank connected by sluice pipes, so that the sea water forces the AvGas from the outer tank into the inner tank, from the inner tank to the drawoff tank, and from the drawoff tank to the suction of the AvGas pumps.

The sea water supply to the AvGas stowage tank is provided by two sea-water pumps which take water from a sea chest. These pumps pressurize the stowage tank and maintain a positive flooded suction at the AvGas service pumps. These sea-water pumps discharge into a common header which delivers sea water to a standpipe extending from the bottom of the outer tank to an overboard discharge line above the ship's waterline. The height of this line establishes the required AvGas pump suction with a positive pressure. The overboard discharge line also provides the relief that limits the pressure which can be placed on the tanks to avoid exceeding the limit of the top pressure of the tank.

An air vent leads from the top of the sea water overboard discharge loop directly to the outside of the ship, to break the siphoning effect. The AvGas is forced up to the fueling stations located on the hangar deck and the flight deck by the two AvGas service pumps which take suction from the AvGas drawoff tanks.

At each AvGas fueling station, there is one electric-motor-driven defueling pump. A hose is furnished for each reel, for fueling and defueling. The defueling pumps take their suction from the discharge side of the fuel-defuel valve and discharge to the AvGas riser. The fueling setting of the fuel-defuel valve is made by completing the electrical ground of the hose nozzle and operating the toggle switch on the switch housing. The defueling and the hose-emptying operations are set automatically whenever the electrical circuit is broken.

When defueling is to be accomplished in the AvGas system, the sea-water pumps are not operated and the AvGas pumps are bypassed after being used to fill the system to eliminate air and vapor. The AvGas defueling pumps are able to draw the AvGas from the helicopter tanks and to return it to the ship's AvGas tanks below, bypassing the station filters and the automatic control assembly with sufficient pressure to force the sea water in the AvGas tanks overboard via the sea-water overboard discharge line.

The drawoff tanks are equipped with a hand-operated stripping pump for the removal of sea water and other impurities which have settled in the AvGas tanks. The AvGas tanks are enclosed by a cofferdam filled with inert gas. If inert gas is not available, the cofferdam may be charged with CO_2.

The AvGas tanks and the cofferdam are normally sealed; however, the AvGas tanks can be emptied, flushed out at sea, steamed until gas-free (preferably at a shipyard), and entered for inspection and repairs. Before AvGas tanks can be entered, the requirements of NAVSHIPS Technical Manual, Chapter 9920 (old chapter 92), section VI, must be met.

The AvGas piping system can be drained of fuel and filled with inert gas by injecting the gas into the system at the AvGas pumproom, with the inert gas control valve in the AvGas pumproom set at the pressure required to force sea water from the AvGas tank overboard via the sea-water overboard discharge line. The inert gas rises through the AvGas in the piping and forces the AvGas into the AvGas tanks. The tank stop valve must be closed after the reflex glass in the suction header shows that the pipe is empty. By this means, no inert gas is allowed to enter the AvGas tanks.

The installation is designed to keep the AvGas stowage tanks entirely full at all times, either with AvGas on top of the sea water or completely filled with sea water. Sea water replaces the AvGas as the AvGas is drawn off, preventing formation of pockets of AvGas vapor at the top of the tank.

An overboard discharge line is provided on the sea-water side of the system. This line is used to discharge the excess delivery of the sea-water pumps and to drain the tanks when necessary. It is also used to discharge sea water displaced in the AvGas stowage tank when receiving AvGas from filling or defueling operations.

The height and the size of the overflow loop in this line limit the pressure in the AvGas stowage tank. The overflow is open at all times to allow sea water to discharge overboard and to prevent overpressure of the stowage tank due to the operation of the sea-water pumps or the expansion of the liquid.

The AvGas system can dispense AvGas at 400 gpm and receive AvGas at approximately 1,750 gpm without exceeding the allowable top pressure of the tank–13 psi.

The AvGas stowage tank is equipped with a water-filled, static-head, liquid-level gaging system.

Two electric-motor-driven sea-water pumps (200 gpm each) are connected to a common suction header in the AvGas pumproom. The suction header is supplied with sea water from a sea chest, thereby giving the sea-water pumps a flooded suction. These pumps discharge sea water into the AvGas stowage tank near the bottom to force AvGas into the drawoff tank and through to the suction header of the AvGas pumps. The sea-water pumps are also used to evacuate sea water from the AvGas stowage tank when draining the tank.

AvGas Fueling Stations

The AvGas fueling stations for the LPH are similar to the Cla-Val station on the CVAs with the exception that a filter is installed at each station.

The designed capacity of each AvGas fueling station is 200 gpm fueling and 50 gpm defueling, measured at the hose reel connection.

Each AvGas fueling station consists of the following: one motor-driven positive displacement defueling pump, two automatic pressure regulating fuel/defuel valves, two hand-operated hose reels with 1 1/2-inch hose, and the valves and controllers necessary for the operation of the station.

The gasoline from the supply riser passes through a 300-gpm filter/separator at the fueling station.

Each filter is the through-flow type. One filter is provided for each of the four AvGas fueling stations.

The filter consists of a main shell and contains twenty coalescing elements and twelve separator elements.

The coalescing elements perform a dual function. They resolve any finely dispersed water into droplets of such size as to permit removal by gravity through the fallout chamber drain. In addition, they are filtering mediums which remove a large proportion of solid contaminants. The flow through the coalescing elements is from inside to outside.

The separating elements at the upper end of the shell remove the final traces of the coalesced water which has not dropped to the fallout chamber by gravity. The flow through the separating elements is from the outside to the inside.

The separated water and waterborne solids drop from the main stream of fuel into the fallout chamber. This water flows overboard from the fallout chamber through the automatic waterdrain valve.

The pressure drop across the filter should be noted each time the station is put into operation and should be observed during operation. The difference in the reading of the pressure gage connected to the inlet of the filter and the reading of the gage connected to the fallout chamber of the filter is the pressure drop across the filter.

The defueling pump discharge returns to the supply riser below the filter. Inert gas is supplied to each station for draining back the system.

AUTOGAS SYSTEM

This system provides stowage, fueling, and defueling facilities with a maximum of safety, for combat vehicles utilizing AutoGas as a fuel.

When AutoGas is taken aboard, the AutoGas pumps and a high-point vent connection are used to prepare the system for filling by eliminating air, vapor, or inert gas from the system. The AutoGas pumps must be shut down after the air, vapor, or inert gas has been eliminated from the system.

AutoGas must be delivered to the ship with sufficient pressure to force the AutoGas into the drawoff tank and to force the sea water overboard through the overboard discharge line.

The AutoGas stowage tank consists of an outer tank and a drawoff tank only. The tank is located on the centerline of the ship between the two AvGas stowage tanks. It extends from the aft bulkhead of the AvGas stowage tanks only part way between them. The cofferdam that surrounds the AvGas stowage tanks also provides protection for the AutoGas tanks.

The AutoGas stowage tank is equipped with a water-filled, static-head, liquid-level gaging system. A flowmeter equipped with a totalizer is installed to measure flow in either direction.

The AutoGas in the AutoGas tank is floated on top of sea water to prevent air or vapor accumulation in the tank. The bottom of the drawoff tank and the top of the stowage tank are connected by a sluice pipe so that the sea water forces the AutoGas from the stowage tank into the drawoff tank and from the drawoff tank to the suction of the AutoGas pumps.

The sea-water discharge from the AutoGas turbines is routed to both the AutoGas outer tank and the sea-water overboard discharge line. This maintains a positive flooded suction to the AutoGas pumps. The height of the overboard discharge line establishes the required positive pressure to the AutoGas pump suction and also provides the relief that limits the pressure that can be placed on the tanks to avoid exceeding the limit of the top pressure of the tank.

An air vent leads from the top of the sea-water overboard discharge loop directly to the outside of the ship to break the siphoning effect. The AutoGas is forced up to the fueling stations located on the hangar deck and the flight deck by the two AutoGas service pumps which take suction from the AutoGas drawoff tanks.

AutoGas Service Pumps

The AutoGas pumps, located in the AvGas pumproom are used to supply AutoGas to the vehicle fueling stations for fueling of combat vehicles and also to off-load AutoGas.

Two sea-water, turbine-driven, AutoGas pumps rated at 160 gpm each at 90 psi are installed in the AutoGas system.

The system is designed for a flooded suction to the AutoGas pumps. This is due to the sea water exhausted from the sea-water turbines being routed into the AutoGas tanks, forcing the AutoGas into the suction header.

The AutoGas pump discharge piping is fitted with recirculating lines orificed to allow a flow of 8 gpm per pump and is installed to prevent overheating of the AutoGas pumps during zero demand.

Sea water under pressure is supplied to drive the AutoGas pumps from the ship's fire main. A pressure reducing valve is provided to control the sea-water pressure to the sea water turbine. A bypass line is fitted around the pressure reducing valve for manual control of the pump. The sea-water discharge line from the turbine is connected to the overflow loop where it supplies water to the stowage tanks or is directed overboard through the loop. This is the same loop that controls the sea water pressure to the AvGas stowage tanks.

For further information in regard to operation and maintenance to the turbines refer to Technical Manual NAVSHIPS 347-3477.

AutoGas Fueling Stations

The AutoGas fueling stations are identical to those previously described in the AvGas system with the exception of the designed capacity.

The designed capacity of each AutoGas station is 100 gpm fueling and 50 gpm defueling, measured at the hose reel connection.

AutoGas fueling stations having the hose reel equipped with 150 feet of 1 1/2-inch hard hose may be expected to produce a flow rate of approximately 65 gpm fueling and 35 gpm defueling.

There are two AutoGas fueling stations on the flight deck and one AutoGas fueling station on the hangar deck.

At each AutoGas fueling station, there is one electric-motor-driven defueling pump. A hose is furnished for each reel for fueling and defueling. The defueling pumps take their suction from the discharge side of the fuel-defuel valve and discharge to the AutoGas riser. The fueling setting of the fuel-defuel valve is made by completing the electrical ground of the hose nozzle and operating the toggle switch on the switch housing. The defueling and the hose-emptying operations are set automatically whenever the electrical circuit is broken.

When defueling is to be accomplished in the AutoGas system, the AutoGas service pumps are bypassed after being used to fill the system to eliminate air and vapor. The AutoGas defueling pumps are able to draw the AutoGas from the vehicle tanks and return it to the ship's AutoGas tanks below, bypassing the station filters and the automatic control assembly with sufficient pressure to force the sea water in the AutoGas tanks overboard through the sea-water overboard discharge line.

The AutoGas piping system can be drained of fuel and filled with inert gas by injecting the gas into the system at the AutoGas fueling stations, with the inert gas control valve at the fueling stations set at the pressures required to force the sea water from the AutoGas tank overboard through the sea-water overboard discharge line. The inert gas forces the AutoGas into the AutoGas tank, and the tank-top valve is closed after the reflex glass in the suction header shows that the pipe is empty. By this means, no inert gas is allowed to enter the AutoGas tanks and form a pocket at the top of the tanks.

Water-Filled, Static-Head Liquid-Level Gaging System

A water-filled, static-head, liquid-level gaging system (fig. 5-20), used to indicate the quantity of gasoline or AutoGas in the stowage tanks, consists of a sensing bellows, two sump tanks, a reducing station for sea-water supply, and the associated piping.

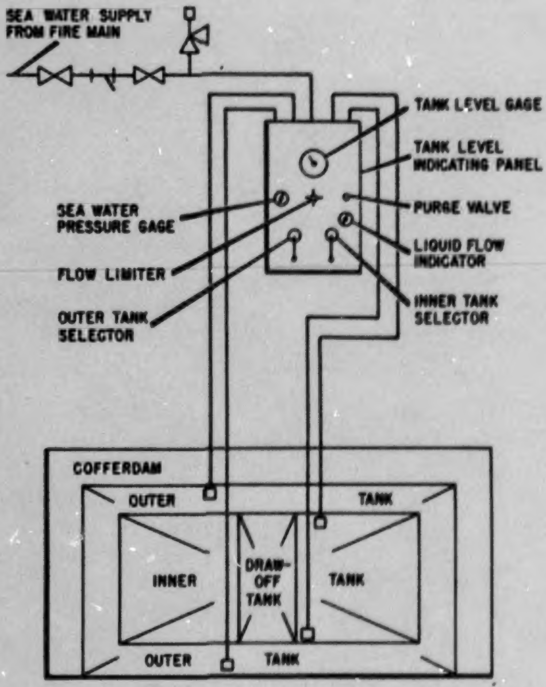


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Figure 5-20.—Water-filled, static-head, liquid-level gaging system.

The differential head pressure, due to the difference in specific gravities of the two liquids (gasoline and sea water) is measured by the sensing bellows calibrated to indicate the quantity of gasoline in gallons.

The two tank-level-indicator (TLI) panels for the AvGas system have two selectors for reading, purging, and zeroing the gage. One panel is for the inner tanks, and one panel is for the outer tanks. The two selectors on each panel are for the port and starboard tanks served. The outer tank gage is calibrated so that at its lower limit—zero point—it indicates the total capacity of the inner tanks and the drawoff tank. The inner tank gage is calibrated so that, at its lower limit, it indicates the capacity of the drawoff tank.

The sensing bellows are located in the AvGas pumproom. One sump tank is located as close as practicable to the outer tank top, and the other sump tank is located as close as practicable to the tank bottom. The sensing bellows is connected by sea-water-filled copper-nickel tubing to each sump tank for measuring the difference in the pressure head acting on each sump tank.

This type of gaging system may also be installed in the gasoline stowage tanks aboard the CVA and CV class carriers in place of the cleavage gage type of system.

OPERATION OF AVGAS SYSTEMS

Since piping arrangements and valve numbers vary from ship to ship, only general information concerning the various operations of the AvGas system is discussed in this course. The valve alignment for each operation on a particular carrier is given on an instruction board in the AvGas pumproom of that ship. An operating diagram is also installed in each pumproom for showing the system alignment at all times. A similar operation board with applicable instructions is provided for ships with AutoGas systems.

The fueling of aircraft as discussed in this chapter pertains only to the operation of the carrier's AvGas system. Aircraft fueling procedures are discussed in chapter 11 of this manual.

The following procedures are for ships having automatic fuel/defuel valve (Cla-Val) fueling stations. The procedures for ships having other type stations are very similar, with minor differences in station operation. For the proper procedures involving a particular ship, check the technical manual for that ship.

FUELING AIRCRAFT

Prior to fueling operations, the correct stripping and sampling procedures must be accomplished for the drawoff tanks. The procedures for preparing the AvGas system for the fueling of aircraft are as follows:

1. Check that the CO_2 flooding system is in working order.
2. The piping system will normally be in a secured condition charged with nitrogen.

Release the nitrogen by opening the 1 1/2-inch vent connection in the distribution system at the nearest fueling station. When the pressure in the system drops to 0 psi, close the vent.

3. Start the sea-water system in operation with one sea-water pump.

4. Line up the distribution system to take suction from the drawoff tank and to deliver to the fueling stations through the pressure regulating equipment and the filter.

5. For each AvGas pump to be placed in operation, open the pump recirculating line and the recirculating line beyond the venturi to discharge to the drawoff tank. One sea-water pump must already be running for each AvGas pump to be placed in operation. Start up one main AvGas pump. Start the second pump as needed to keep up with the demand from the fueling stations. One AvGas pump will normally supply about four hoses simultaneously.

6. Vent the filter until gasoline appears in the filter vent sight glass. Then open the vents at the deck fueling stations fitted with vent connections until gasoline appears at the vent connection.

7. Connect the fueling nozzle ground wire to the aircraft and the aircraft ground wire to the ship's metal structure. START THE DEFUELING PUMP. Insert the fueling nozzle into the aircraft and start the fueling operations. The defueling pump must be in operation for the fueling-defueling valve to function properly.

8. At the end of a fueling operation, remove the hose nozzle from the aircraft and put the two-way deck fueling valve in the defueling position by breaking the ground connection with the switch or by removing the clip from the aircraft.

9. After all fueling operations are complete, drain the system and then charge it with inert gas.

DEFUELING AIRCRAFT

The defueling of aircraft can be accomplished simultaneously with fueling operations or can be accomplished as a separate operation. Reciprocating-engine aircraft and jet aircraft cleared only for AvGas are to be fueled only on the starboard side of the ship. Likewise, these types of aircraft are to be defueled only on the starboard side.

When fueling and defueling aircraft simultaneously, the following defueling procedure must be observed:

1. Ground the fueling nozzle to the aircraft and ground the aircraft to deck metal. Insert the fueling nozzle into the aircraft.

2. Start the deck defueling station pump. Shift the controls to the fueling position and prime the hose line for about 12 seconds. Then shift the controls to the defueling position. This will pump gasoline from the aircraft back into the system where it will mix with the gasoline being delivered to other aircraft.

3. After defueling is complete, close the hose nozzle and remove from the aircraft.

4. Secure the fueling station defueling pump and remove the electrical ground connections.

When defueling an aircraft as a separate operation, the following procedure should be used:

1. For this condition the system will normally be secured and charged with nitrogen gas. Release the nitrogen pressure by opening the 1 1/2-inch vent connection. When the pressure in the system drops to 0 psi, close the vent.

2. Line up the distribution system to the deck fueling station or stations to be used for defueling. Open the bypass around the filter, pressure regulating equipment, and the gasoline pumps to the drawoff tank. If the outer tank is nearly full of gasoline, close the sea chest valve.

3. Ground the aircraft to deck metal and the fueling nozzle to the aircraft. Insert the fueling nozzle into the aircraft.

4. Start the deck defueling station pump. Shift the controls to the fueling position and prime the hose line for about 12 seconds, then shift the controls to the defueling position.

5. Allow the defueling pump to empty the hose by continuing to run. After defueling is complete, close the hose nozzle and remove from the aircraft.

6. When the hose is empty, secure the defueling pump station and remove the electrical ground connections.

7. When defueling operations are completed, drain the system and then purge and charge it with nitrogen.

CAUTION: Before defueling any aircraft, check the aircraft logbook to see if a RED DYE has been added to the fuel for the detection of fuel leaks in the aircraft fuel system. If the red dye has been added, the fuel must NOT be returned to the stowage tanks.

DRAINING AND SECURING AVGAS DISTRIBUTION SYSTEM

At the completion of any AvGas handling operations, the piping must be drained of gasoline, purged of gasoline vapor, and charged to 10 psi with nitrogen in order to minimize fire and explosion hazards. Nitrogen at 10 psi is provided in the gasoline pumproom by a 1 1/4-inch supply line. From this line, leads are taken off to the filter room, the recirculating lines, and the drawoff tank suction lines. The lead to the filter room has three branches, one to each filter outlet and one to the filter bypass.

To drain and secure the AvGas system the following procedure should be used:

1. Close all deck fueling station inlet cutout valves. Check that all the fueling station vents and the main deck filling line cutout valves are closed. Close all the sea-water valves except those locked open.
2. Open all the gasoline distribution piping valves including the bypass valves except those valves closed in step 1. Admit 15 psi nitrogen through the connection at the filter bypass. The nitrogen will bubble up through the AvGas to the high points in the system, displacing the AvGas and forcing it to drain back to the drawoff tank. Open the overboard drain line bypass valve from the filter fallout chamber to drain off water in the filter. When AvGas appears in the filter overboard drain line sight glass, close the overboard drain line bypass valve and open the drain line from the filter fallout chamber to the riser from the pumproom to drain the filter.
3. When the reflex gage in the pumproom indicates that all the AvGas has drained from the system, close the valve between the drawoff tank and the suction header (tank-top valve), and close all independent recirculating line valves that lead to the drawoff tank. Care must be taken to prevent nitrogen from entering the stowage tank as it may form a nitrogen gas lock in the tank that must later be bled off through the distribution piping.
4. Close the nitrogen inlet valves to the distribution piping in the filter room and admit nitrogen to the system through the connection in the pumproom. Connect a portable inertness analyzer to the fueling stations provided with vent connections and charge the system to 10 psi. Check the inertness reading to determine that 50 percent or more has been obtained. Check the inertness reading also at each fueling station. If the correct inertness reading has not been obtained, bleed off some nitrogen and build the system up to 10 psi again and recheck the inertness reading.
5. For draining and securing, after operations in which the filter is bypassed, leave the filter as already cut out and admit nitrogen for draining the system through the nitrogen connection to the filter bypass. The rest of the procedure, except for draining the filter, will be the same in principle as outlined above.

RECEIVING AVGAS

AvGas is received aboard ship through the starboard filling connection located on the main deck.

Prior to going alongside the tanker, certain preparations must be made. First, establish the amount of aviation gasoline to be received and the number and location of the tanks to be filled. If time permits, the number of tanks to be filled should be reduced to a minimum by transferring fuel from the forward tanks to the after tanks on ships that are so equipped.

NOTE: All rigging of lines and span wires and other gear is normally done by one of the deck divisions.

At the filling connection, remove the blank flange and install the spool assembly. The spool assembly is equipped with a pressure gage, thermometer, and a valved vent connection.

Bolt the spool to the filling connection, using a Buna-N gasket. The male end of the quick-release coupling is bolted to the outboard end of the spool, using the same type of gasket.

Two sound-powered telephone headsets are used for communications, one set for ship-to-ship and the other for the 4JG circuit on the ship.

The following equipment must be readily available:

The fuel sampling kit with an adequate supply of clean jars for taking samples as often as the fuels officer requires.

A 5-gallon safety can, rubber buckets, rags, and swabs for cleaning up and disposing of any gasoline which may have been spilled during fueling operations.

CAUTION: Only nonsparking tools will be used for making up the connections.

For the initial filling of the tank with AvGas, the following procedures should be used.

1. Introduce sea water into the tank by gravity from the sea head until the reflex gage at the base of the gasoline pump suction header indicates the presence of liquid. Then close the valve in the gasoline suction line between the drawoff tank and the reflex gage. Close all sea suction valves except the locked open leak-off valve to avoid the possibility of discharging overflow gasoline through the bottom of the ship and short circuiting it into other suction sea chests. Check that the sea-water overflow valve in the filter room is locked open.

2. Prior to filling, line up the valves in the piping to bypass the filter, pressure regulating equipment, and AvGas pumps.

3. Ground the tanker or barge to the filling connection, remove the blank flange, and connect the fueling hose to the filling connection. Vent the system through the 1 1/2-inch hose attached to the vent at the filling connection. Insert the hose nozzle in a safety can and permit the displaced nitrogen to escape as gasoline is pumped into the system. Open the filling connection valve. Then order the tanker to start pumping very slowly. When fuel appears at the vent hose, close the vent valve. Then check the reflex gage at the AvGas pump suction header to see that it is full. Open the valves between the reflex gage and the drawoff tank and order the tanker to increase filling to a normal rate.

4. When the level gage indicates that the outer tank is almost full, stop the fill operation. Allow sufficient room in the gasoline tank for drain-back of all gasoline in the piping and equipment.

5. Uncouple the fueling hose, disconnect the ground wire, and replace the blank flange.

6. Drain the gasoline piping to the stowage tank by admitting 15 psi nitrogen to the distribution piping at the filter bypass and suction header to displace the gasoline in the piping.

7. When the reflex gage on the suction header indicates the gasoline level has fallen below the header, close the drawoff tank cutoff valve.

8. Open the sea chest valve.

9. To purge the filling piping, line up all valves in the piping to bypass the AvGas pumps, the pressure regulating equipment, and the filter. Open the 8-inch filling line valve in the filter room. Admit nitrogen to the filling piping through the 1 1/4-inch nitrogen supply line in the gasoline pumproom. Allow the nitrogen pressure to build up to 10 psi and then close the supply line valve. Take inertness readings at the main deck filling test connection to see if an inertness of 50 percent or better has been achieved. If not, bleed down the system, recharge to 10 psi, and again check the inertness reading.

Emergency Breakaway

At times, during refueling operations at sea, emergencies may arise that require quick release of the fueling hose and lines connecting it to the ship.

The lines that are connected to the ship are cut away with a fire axe. The span wire is released by tripping the pelican hook.

The hose is released by releasing the quick-disconnect fitting on the fueling hose. The connection valve must be closed as soon as possible if there is not time to close it before releasing the hose.

Only the male half of the coupling and valve combination is used aboard the ship receiving the fuel. This half contains the valve operating lever and bolts directly to the fueling connection.

The female half of the quick-disconnect coupling is carried by the tanker and is fitted to the end of the fueling hose sent over by the tanker. This half contains the valve and is spring-loaded to close when the two halves are taken apart.

The two halves of the coupling are held together by means of hardened steel balls backed by a spring and installed in the female half. These balls snap into grooves machined into the male half when the two halves are connected. (See fig. 5-21.)

The valve lever must be in the closed position when connecting the two halves. The valve is opened after the two halves are locked together.

Under emergency conditions, the coupling may not release when there is a strain on it. The riding line can be taken up to release the strain.

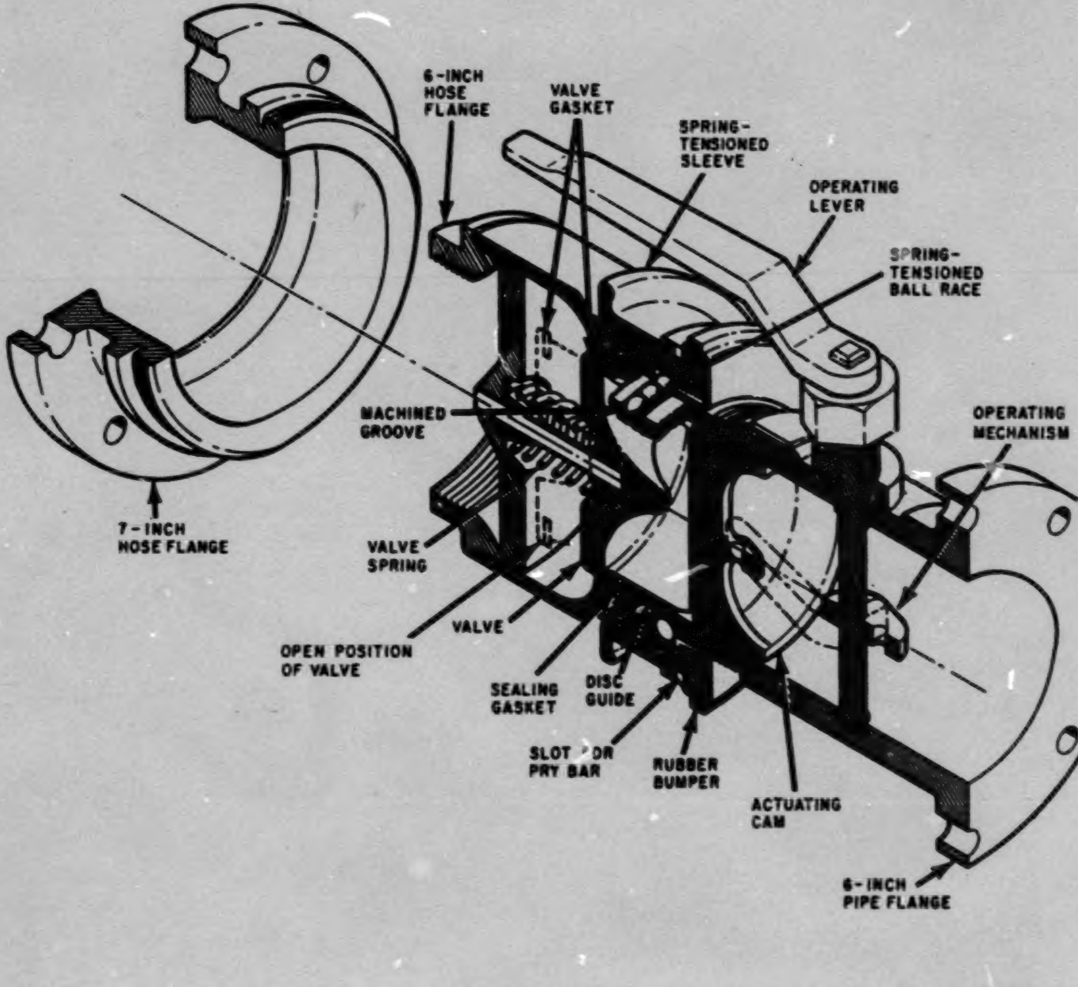
6-INCH HOSE FLANGE
VALVE GASKET
SPRING-TENSIONED SLEEVE
OPERATING LEVER
SPRING-TENSIONED BALL RACE
OPERATING MECHANISM
MACHINED GROOVE
7-INCH HOSE FLANGE
VALVE SPRING
VALVE
OPEN POSITION OF VALVE
SEALING GASKET
DISC GUIDE
SLOT FOR PRY BAR
RUBBER BUMPER
ACTUATING CAM
6-INCH PIPE FLANGE

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Figure 5-21.—Quick disconnect and valve combination.

SAFETY PRECAUTIONS

These safety precautions apply only to system operations. The safety precautions for aircraft fueling and defueling are covered in chapter 11 of this training manual. The safety precautions are as follows:

1. AvGas vapor is highly flammable and explosive when mixed with the right proportions of air. Also, AvGas contains tetraethyllead which is poisonous to the human system. Because of these dangerous properties, all precautions listed in the NAVSHIPS Manual, Chapter 9150, Gasoline (Aviation and Automotive and JP-5 Fuel Systems), must be strictly observed when handling AvGas.

2. Before starting any AvGas handling operations, check that nothing has been stowed that will interfere with access to the pull boxes for the pumproom, pump motor room, and gasoline filter room fixed flooding CO_2 fire extinguishing system. Also check that nothing has been stowed that might interfere with the proper operation of the CO_2 release mechanism at the CO_2 bottle racks. Be sure that the CO_2 bottles are properly connected to the manifold.

3. No tank or cofferdam may be entered until the air inside has been determined to be safe by testing FIRST with a combustible gas indicator (for explosive vapors) and SECOND with a flame safety lamp (for sufficient oxygen). Detailed information on the requirements that must be met before entering gasoline tanks or cofferdams is contained in chapter 9920 of the NAVSHIPS Technical Manual.

4. The flow of AvGas through a hose generates and accumulates static electricity. Therefore, BEFORE connecting the hose to a filling connection or attaching a hose nozzle to an aircraft, it is necessary to GROUND ALL HOSE LINES AND NOZZLES to equalize the static electric charge. Do not disconnect the ground connections until AFTER the hose or nozzle has been removed.

5. Always purge and inert a distribution system after use to minimize fire and explosion hazards.

6. Do not allow nitrogen to enter the drawoff tank during purging and inerting operations. Nitrogen may cause the drawoff tank to become gas locked, and thus necessitate venting the tank.

7. DURING FILLING OPERATIONS, DO NOT EXCEED THE ALLOWABLE PRESSURE AT THE TOP OF THE STOWAGE TANK AS INDICATED BY THE RED HAND ON THE TANK-TOP PRESSURE GAGE LOCATED IN THE PUMPROOM.

8. The sea-water chest valve for the gasoline system sea-water pumps must be closed during filling and draining operations to prevent any overflow gasoline from being drawn up into the fire main system.

9. When flushing and emptying the stowage tank, periodically inspect the sea-water pump seals for any damage caused by aviation fuel passing through the pump.

10. Conduct monthly hydraulic control tests on service filter/separators.

11. Secure the AvGas filter when tests indicate that the elements in the filter are defective.

RECORDS AND REPORTS

In the maintenance and operations of an AvGas system, it is necessary that numerous records, reports, and logs be kept for a smooth-running organization.

A rough log is maintained by each pumproom. This log is a record of all the operations performed in the pumproom. The amount of gasoline in each stowage tank that is associated with the pumproom should be recorded at the beginning of each day's operations before the system is charged. The amount is again recorded when the system is secured. Each time a pump is started, the pump number and the time should be recorded. When the pump is stopped, it should also be recorded. The cofferdam pressure and inertness reading should be entered in the log at the beginning of operations each day. All discrepancies or unusual conditions should be entered, along with the time and circumstances surrounding the discrepancy or condition. An entry should be made indicating that the daily, weekly, and/or monthly inspection was made. The daily, weekly, and monthly inspections are as follows:

DAILY:

1. Rotate all AvGas and sea-water pump shafts by hand to check for binding. Place pump out of commission if binding is found.
2. Check for proper oil level in the constant-level oiler cups of AvGas pumps. Refill if necessary, using Navy Symbol 2190T oil.
3. Check the overboard discharge valves for proper operation. Operate the check valve by hand.
4. Check the nitrogen pressure in the AvGas distribution piping, in the cofferdam surrounding the AvGas (or Auto Gas) stowage tank, and in the double-walled piping. Take percent inertness readings of the cofferdam and record the readings on a log sheet. When charged with nitrogen, the desired cofferdam inertness reading is 50 percent or above at 1/2 psi. The desired pressure in the double-walled piping is approximately 10 psi. (On some ships this pressure may be higher.)
5. Check for nitrogen, sea water, and AvGas leaks.
6. Inspect the packing gland on sea-water pumps for proper adjustment while the pumps are running. Adjust for slight leakage (approximately 2 drops per minute).
7. Check that the sea-water leak-off valve is locked open at all times.
8. Check all locked valves for correct positions.
9. Check the strainers in overwing and underwing nozzles for cleanliness.

WEEKLY:

1. Lubricate valve spindles on plug valves.
2. Renew grease in sea-water pump grease cups if necessary. Turn grease cups down 1/4 turn.
3. Check packing in bulkhead stuffing boxes of sea-water pump and AvGas pump shafts for wear. Renew grease if necessary.
4. Check directional arrows on all plug valves for correct alignment of ports. Arrows should line up with slots on the valve spindles. Repair as necessary.
5. Check all gate valves on sea water side for freedom of operation. Repair or lubricate as necessary.

MONTHLY:

1. Operate all pumps and test for vibration, leaks, excessive heating, and sound of bearings.

CAUTION: Do not run pumps dry, or serious damage will result.

2. Inspect all ladders and grab irons for security.
3. Check condition of safety lines, hose line air masks, and oxygen breathing apparatus (OBA) equipment.
4. Check flight deck edge hose rollers for freedom of rotation, and grease if necessary.

All logs that are maintained in the pumproom, filter room, etc., are kept in the rough. Periodically, the information in these logs should be transferred to the smooth log that is maintained in the division office, since the aviation fuels officer is required to maintain a record of these reports.

DAILY FUEL REPORT

Each day at the completion of operations a fuel report is made out by the petty officer in charge of each pumproom. This report includes the liquid-level indicator reading at the beginning and completion of fueling operations for the day, the inert gas pressure and inertness reading in the cofferdams.

This information is used in the accounting of the fuel expenditures and is included in the daily fuel report forwarded to the commanding officer. An additional copy of this report is forwarded to the air officer, OOD, engineering officer, operations officer, aviation fuels officer, and the aviation supply officer.

REPLENISHMENT REPORT

A replenishment report must be submitted within four hours after a replenishment with copies forwarded to the operations officer, OOD, and the V-4 files.

CHAPTER 6

HIGH-CAPACITY JP-5 SYSTEMS

In order for the ABF3 and ABF2 as well as the ABFAN to better understand the JP-5 fuel system, it will be necessary to review briefly the history of the system.

When jet aircraft first became operational in the fleet, they burned 115/145 aviation gasoline. The original high-capacity system was capable of effectively refueling this new high-speed aircraft, but the jets could not operate efficiently on aviation gasoline due to the high evaporation of the fuel encountered during rapid climb.

New jet fuels were developed to replace 115/145 aviation gasoline as the primary jet fuel. These fuels, JP-3 and JP-4, are highly volatile and require the same protective stowage as aviation gasoline. With the introduction of this new jet fuel in the fleet, it became obvious that aircraft carriers did not have sufficient fuel stowage capacity available for both 115/145 and the new jet fuel for extended flight operations. Since an increase in the protected fuel stowage space (saddle tanks) was not practical, a fuel which could be stowed in unprotected tanks was required. It was found that JP-5, heavy end aviation fuel (or HEAF as it was known then), when blended in proper proportions with aviation gasoline 115/145, produced a jet mix that was equivalent to JP-3 and JP-4. With this new development, it was necessary to modify our present high-capacity system to manufacture and stow this fuel aboard ship.

A number of the ship's black oil tanks were converted to JP-5 stowage tanks. These tanks were arranged in two groups, one group forward and one group aft. Each group had an equal number of port and starboard tanks. Although the normal stowage capacity of ship's black oil fuel was decreased somewhat, the ship's range was not affected, as JP-5 could, in an emergency, be used as boiler fuel. Consequently, some means had to be provided to deliver JP-5 to the engineers in the event of this emergency. Eight amidship wing tanks (four port and four starboard, two per boilerroom), which are normally empty voids, were designated as EMERGENCY SERVICE TANKS for this purpose. A transfer main running fore and aft interconnected the forward and after group of JP-5 stowage tanks and the emergency service tanks. A number of filling connections installed on the port and starboard side of the hangar deck were interconnected with the transfer main by downcomers.

Four JP-5 transfer pumps were installed on the seventh deck level, two forward and two aft. These pumps were of the 1,000 gpm at 100 psi centrifugal-type. A blender was installed in each aviation gasoline pumproom (first platform). The suction header of the transfer pumps was connected to the fore and aft transfer main. The discharge header was connected to one side of the blender. The piping in the aviation gasoline pumproom was modified to enable the starboard AvGas pumps to discharge into the other side of the blender.

JP-5 was received aboard through the hangar deck filling connections and directed via the transfer main to the forward and after group of stowage tanks. An equal number of port and starboard tanks were filled as a unit. After the JP-5 was allowed to settle for a prescribed length of time, it was stripped of all water and solids. The existing black oil stripping system was utilized for this purpose.

The transfer pumps then took suction from an equal number of port and starboard stowage tanks and discharged into one side of the blender. Only one pump in each pumproom was used for this operation. The other was designated as a standby. Simultaneously, one of the starboard AvGas pumps was used to transfer aviation gasoline from the starboard set of AvGas tanks to the other side of the blender. The end result, JET MIX, was then stowed in the port AvGas tanks both forward and aft. As the JP-5 stowage tanks were emptied, they were ballasted with sea water.

The port AvGas pumps and the port quadrants two and four were used to dispense jet mix to jet aircraft on the portside only. All cross-connecting piping between the port and starboard quadrants was blanked off. With the addition of the wing stowage tanks, the jet mix system resulted in a substantial increase in overall aircraft fuel capacity of the carrier.

The development of a jet engine that could operate efficiently on JP-5 alone caused the jet mix system to become obsolete. However, the conversion from the jet mix system to the interim aviation fuel system was comparatively simple. Four of the existing wing stowage tanks, two forward (one port and one starboard) and two aft (one port and one starboard) were converted to and designated as JP-5 service tanks. A separate filling and a separate suction line and a hand-operated stripping pump were installed in these tanks. The sea water ballast connections were removed.

NOTE: JP-5 service tanks are never ballasted with sea water.

Stripping JP-5 stowage tanks with the black oil stripping system proved time-consuming and wasteful, and an independent JP-5 stripping system was installed. This system had four stripping pumps—two forward and two aft. These pumps served to strip the JP-5 stowage and service tanks of water and solids. The blenders were removed from the aviation gasoline pumprooms. The existing JP-5 pump discharge header was connected directly to the port distribution risers in the aviation gasoline pumproom. The port saddle tanks were returned for stowage of aviation gasoline. The two aviation gasoline pumps that were used for delivery of jet mix were returned as standby aviation gasoline pumps in the starboard quadrant. One of the JP-5 pumps in each pumproom was designated as a transfer pump and the other as a service pump. A first-stage filter was installed between the transfer pumps and the service tanks. The piping to the inlet side of the filter was orificed to limit the flow to 200 gpm.

JP-5 was received aboard in the same manner as in the jet mix system. After it had been allowed to settle for a prescribed period of time, it was stripped of all water and solids and transferred via the transfer filter to the service tanks. After the JP-5 in the service tanks had settled for a second prescribed period of time, it was again stripped of any water or solids remaining. The clean, water-free JP-5 was then pumped from the service tanks through service filters on the third deck to jet aircraft on the flight and hangar decks, via the port quadrant. The piping and valves were so arranged that either of the two existing pumps in each pumproom could be used for transfer or service in an emergency, but one pump in each pumproom was designated as a transfer pump and the other as a service pump.

When attack and fighter aircraft became predominantly jet-engined aircraft in the fleet, it was obvious that the CVA class carriers required a maximum stowage and distribution of JP-5 and a limited stowage and distribution of aviation gasoline. The ultimate JP-5 System (CVA) conversion from the "interim" was a complex one. The forward aviation gasoline pumproom was eliminated. The forward aviation gasoline stowage tanks were converted to JP-5 stowage and/or service tanks. The forward starboard aviation gasoline quadrant became a JP-5 quadrant. The afterport aviation gasoline stowage tanks were converted to JP-5 service tanks. The after starboard aviation gasoline quadrant remained the same, except for the removal of two aviation gasoline and two salt-water pumps which were not required. This conversion gave us a three-quadrant delivery of JP-5 and one of aviation gasoline.

The *USS KITTY HAWK* (CV 63) was the first carrier constructed from the keel up with an original high-capacity JP-5 fueling system. The type of JP-5 system installed on this CV, and all newly constructed carriers thereafter, has a four-quadrant delivery of JP-5 and limited stowage and distribution of AvGas servicing piston-type aircraft on the starboard side only. Except for the additional quadrant and minor changes to the distribution piping to incorporate a newly developed service station (Cla-Val), these systems are practically identical to and patterned after the CVA 59 conversions.

Not all "interim" systems were converted to the CVA system. The operational demand of our carrier fleet required low-speed, long-range, antisubmarine, hunter-killer type aircraft. At that time, only reciprocating-engine aircraft met this requirement. (NOTE: Today, the SH-3 helicopter is used in conjunction with reciprocating-engine aircraft.) Therefore, it was necessary to modify some of the carriers with the "interim" systems which were ideally suited for this type of assignment for a maximum stowage and distribution of aviation gasoline. This was accomplished by converting either quadrants two or quadrants four back to aviation gasoline quadrants. Carriers with this type of system have a three-quadrant delivery of aviation gasoline and one of JP-5.

Two net types of JP-5 fueling systems were introduced with the commissioning of the first newly constructed LPH-2 Class carrier and the first LPD-1 (landing transport dock). Although an LPD is not classified as an aircraft carrier in any sense of the word, it is capable of handling up to six helicopters and does require a complement of ABFs to operate and maintain the aviation fuel systems. In addition to the JP-5 and AvGas, a third system, AutoGas, is also installed on these ships with which the ABF is concerned.

The JP-5 fueling systems installed on the LPH-2 and LPD-1 Class are similar to the CVA/CV in most respects. Except for size and capacity, the only noted difference is the arrangement of the service fuel filters. There is only one JP-5 pumproom serving one 5-inch quadrant distribution riser on each ship. Each pumproom contains two 220-gpm service pumps with maximum distribution capabilities of 400-gpm. The 400-gpm main fuel filter for the LPD is located in the JP-5 pumproom. The LPH-2 Class has one 300-gpm filter at each service station.

There are several different types of JP-5 fueling systems aboard aircraft carriers generally referred to by class ship (CVA/CV, LPH, LPD) on which installed. Each system may vary to some degree as to type, number, location, and capacity of component parts, such as pumps, filters, and service stations, but most characteristics are similar. The operational procedures are practically identical for all systems regardless of the class of ship.

CVA/CV JP-5 SYSTEM

A JP-5 fueling system consists primarily of a stowage system and three separate and independent pumping systems–Filling and Transfer, Stripping, and Service System. The tanks in a JP-5 system are designated under two major categories–stowage and service. Stowage tanks are used for bulk stowage of JP-5, and service tanks are used for servicing aircraft. The stowage capacity of the different class ships depends on the number and size of the tanks available. These will vary as the ships increase in size and class.

SERVICE SYSTEM

The JP-5 service system aboard a CVA/CV is similar in many respects to the AvGas system. Many of the components of the AvGas system are also used in the JP-5 system. The main differences are in the pumprooms and the stowage tanks. Sea water is used to displace the AvGas, keeping the tanks full at all times, and JP-5 is stored aboard ship in a similar manner to Navy Special Fuel Oil (NSFO), and Navy Distillant fuel (ND).

General Description

On the CVA-34 class carrier, there are two JP-5 pumprooms–one forward and one aft. The forward pumproom serves the two forward JP-5 service tanks, and the aft pumproom serves the two after JP-5 service tanks.

The two forward JP-5 service tanks are between the port and starboard torpedo bulkheads No. 4, just aft of the forward JP-5 pumproom; and two JP-5 service tanks are located aft, one port and one starboard, outboard of the port and starboard shaft alley, with the aft JP-5 transfer pumproom located in the starboard shaft alley.

NOTE: Newer carriers have additional service tanks; CV 63 and 64 have four service tanks forward and four service tanks aft.

The JP-5 service tanks have remote reading static head level indicators, located in the JP-5 pumproom. The JP-5 service pumps take suction from the JP-5 service tanks and discharge through meters to service filters in which water and solids are removed from the fuel.

NOTE: Newer carriers do not have this meter installed.

The discharge from the service filters is piped to fore-and-aft distribution mains which run outside of the shell of the ship on both sides of the ship. (On newer ships these mains are internal.) Risers from these mains supply the JP-5 fueling stations on the hangar and flight decks.

At each JP-5 fueling station there is one defueling pump and two hose reels, each with 150 feet of 2½-inch hose with nozzles for fueling and defueling aircraft. One hose is hard and is intended for defueling aircraft. The other hose is collapsible and is intended for fueling aircraft only.

The hard hose is mounted on a motor-operated hose reel, and the collapsible hose is mounted on a manually operated hose reel. JP-5 is supplied to the fueling station by the JP-5 service pumps. Each station has one or more two-way, three-port, diaphragm-operated valves, controlled by solenoid-operated pilot valves, between the riser and the hose reel. Control of the solenoid valves is arranged so that JP-5 may be discharged to the aircraft by one or both hoses, or aircraft may be defueled independently using the hard hose and the defueling pump to pump JP-5 from the aircraft back to the stowage tanks. The defueling operation also empties the hose after the fueling or defueling operation is completed.

The JP-5 filling and transfer system is for receiving JP-5 to the stowage tanks, transferring from the stowage tanks to the service tanks for aircraft fueling, offloading JP-5 and in an emergency to transfer JP-5 from the stowage tanks to the JP-5 emergency tanks for use as boiler fuel.

NOTE: On newer carriers, such as the CV 63 and 64, JP-5 is transferred directly to the ship's fuel oil service tanks.

STOWAGE, OVERFLOW, AND EMERGENCY SERVICE TANKS

The stowage, overflow, and emergency service tanks are part of the JP-5 filling and transfer system.

A stowage tank (fig. 6-1) is one into which JP-5 is received from a tanker, settled and stripped, and then transferred to a service tank through a transfer filter or centrifugal purifier. Rust formation is prevented in these tanks by coating the internal surface with a special protective coating. An atmospheric vent from each stowage tank leads to an air escape main. One vent line for each air escape main rises above the 01 deck level and loops back to about the hangar deck level. An overflow line is also provided for each stowage tank and leads into an overflow tank. A one-way check valve in the overflow line ensures that the overflow from a full stowage tank is directed to the overflow tank and not to another stowage tank.

A copper-nickel suction and fill tailpipe extends from a manifold to a minimum of 24 inches from the bottom of each tank. This pipe terminates in a nonvortex bellmouth that eliminates swirling when pumping JP-5 from the tank.

A stripping tailpipe extends from a single valve stripping manifold to a maximum of 1½ inches from the tank bottom. This line is used for stripping sludge and water from the bottom of the tank. It is also used to remove the JP-5 below the suction and fill tailpipe to another stowage tank for consolidation. The stowage tanks and service tanks can be completely emptied by power-operated stripping pumps.

Overflow tanks (fig. 6-2) are provided so that the stowage tanks are not overtaxed when they are being filled. They also serve as stowage tanks. They are designed to receive the overflow from the stowage tanks and to overflow overboard when they are full. They should always be the last tanks to be filled when receiving JP-5 and the first to be emptied when transferring from the stowage tanks to the service tanks. There is an overflow box fitted into the overboard discharge line from the overflow tank. This overflow box contains a

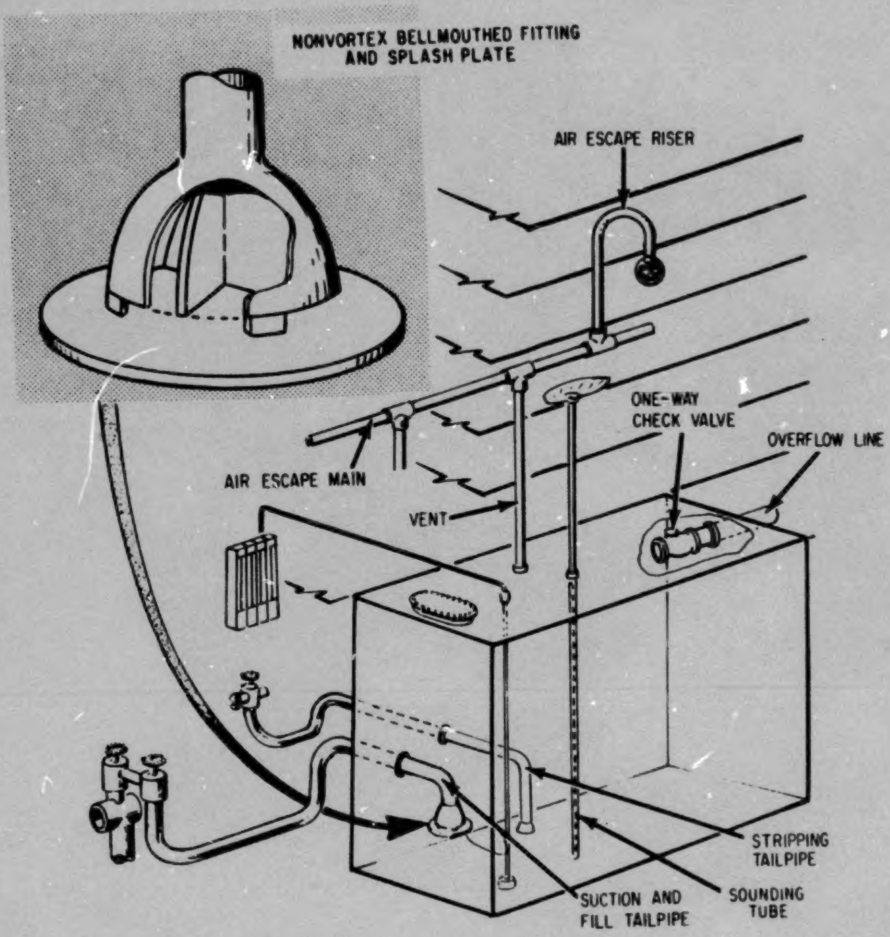
NONVORTEX BELLMOUTHED FITTING AND SPLASH PLATE
AIR ESCAPE RISER
ONE-WAY CHECK VALVE
OVERFLOW LINE
AIR ESCAPE MAIN
VENT
STRIPPING TAILPIPE
SOUNDING TUBE
SUCTION AND FILL TAILPIPE

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Figure 6-1.–Typical JP-5 stowage tank.

check valve and is designed to prevent sea water from flowing back through the line into the overflow tanks.

The emergency service tanks are primarily voids and are an integral part of the damage control underwater protective system. They are located amidship and are used for emergency service to the ship's boilers. JP-5 is never stowed in these tanks, but in an emergency may be transferred to them for use as boiler fuel. Once JP-5 is transferred to these tanks, it is no longer acceptable as aviation fuel and cannot be used as such. These tanks are provided on the older carriers only. On newer carriers, JP-5 is transferred directly to the fuel oil service tanks if JP-5 is required in an emergency for boiler fuel.

Each tank is provided with a sounding tube. The sounding tube is used to measure the quantity of JP-5, to detect water, and to thief fuel samples. The sounding tube is perforated in such a manner that the level of fuel in the tube is the same as that in the tank. Liquid level

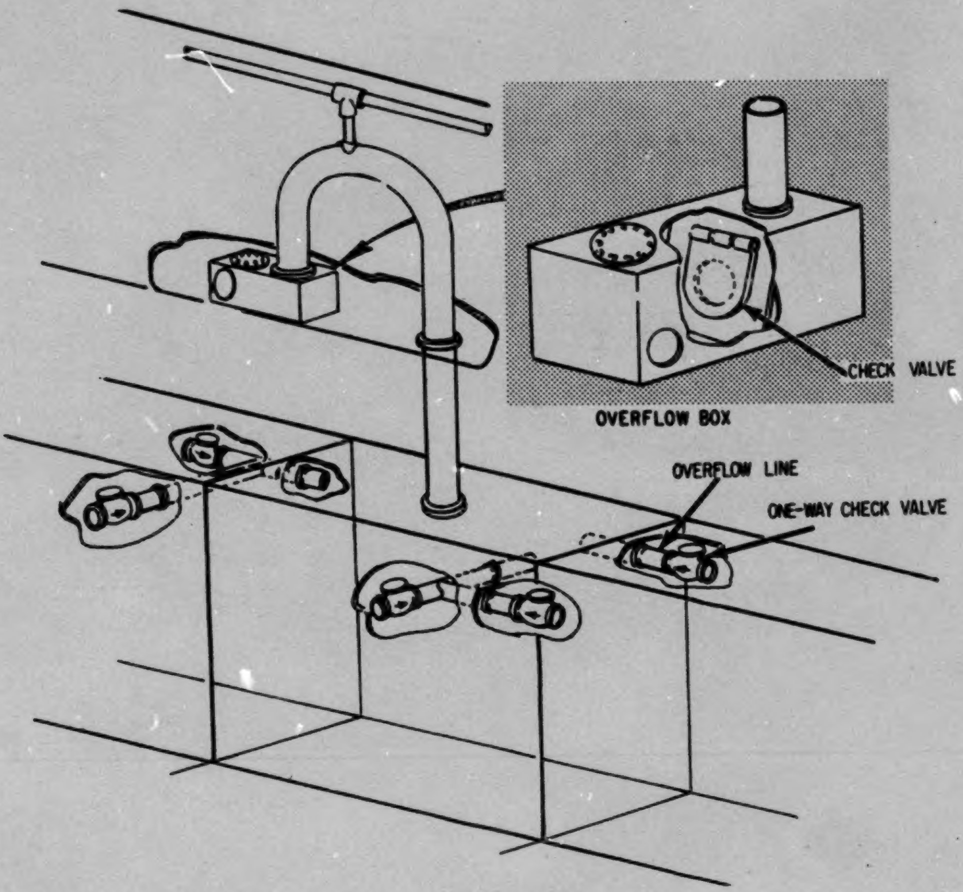

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Figure 6-2.—Typical JP-5 overflow tank.

indicators, used to measure the quantity of fuel, are also installed in each tank.

SERVICE TANKS

On older carriers there are four JP-5 service tanks, two forward and two aft. Each tank (fig. 6-3) is fitted with a filling line, a service pump suction line, a sounding tube, an air escape, a recirculating line, an overflow line, a stripping line, and a remote reading level indicator. These tanks are also coated to prevent rust.

JP-5 is delivered via coalescer-type filter separators or purifiers to the service tanks. Each service tank is fitted with an overflow pipe which discharges overboard into a separate overflow box at the shell of the ship.

In the forward JP-5 pumproom, a 1-inch recirculating line is taken off each service pump discharge. The service pump recirculating lines join with the recirculating lines from the filters on the third deck and discharge to either of the two service tanks for that pumproom. The recirculating lines terminate near the bottom of the service tank.

The recirculating lines are interconnected so that the JP-5 may be recirculated back to the service tank from which a pump is taking suction. Each service tank is fitted with an air escape and a sounding tube.

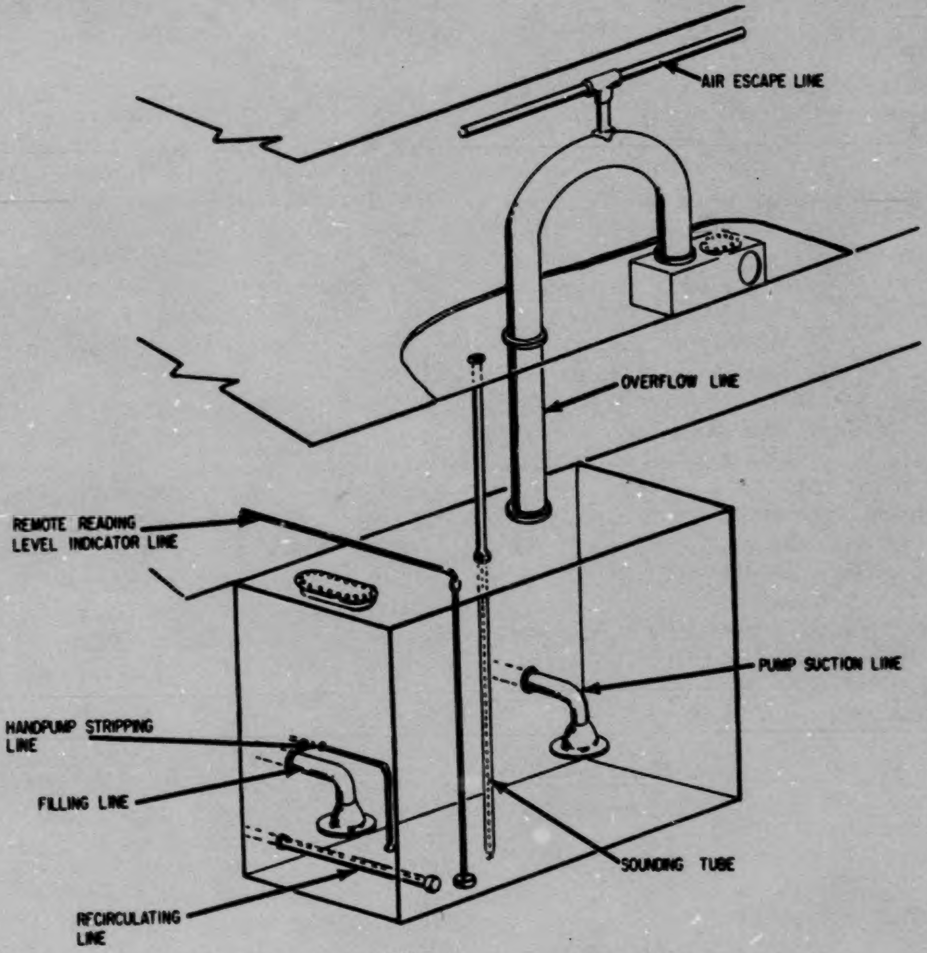
AIR ESCAPE LINE
OVERFLOW LINE
REMOTE READING LEVEL INDICATOR LINE
PUMP SUCTION LINE
HANDPUMP STRIPPING LINE
FILLING LINE
SOUNDING TUBE
RECIRCULATING LINE

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Figure 6-3.–Typical JP-5 service tank.

AIR ESCAPES

The JP-5 tanks are equipped with air escapes to vent the tanks when they are being filled or emptied.

The forward and aft JP-5 overflow or ballast, JP-5 or ballast, and the JP-5 stowage tanks are vented to common air escape headers. There are four air escape mains located forward and aft on the port and starboard sides and are terminated in the weather above the main deck and outboard of the holding bulkhead.

The forward and aft JP-5 service tanks are equipped with separate air escapes off the elbow of the overflow box and terminate in the weather above the main deck outboard of the holding bulkhead.

LIQUID LEVEL INDICATORS

Each JP-5 stowage and service tank is provided with a remote-reading liquid level indicator, regardless of the type of tank. The two liquid level indicators most commonly used in the JP-5 system are the King gage and the

Gems Tank Level Indicating (TLI) System, commonly referred to as the Gems system. The Gems system is replacing the King gages and is discussed later in this chapter.

The following three different types of King gages are presently being used aboard ship:

1. Hand pump model (three-tube system).
2. Compressed air model (two-tube system).
3. Compressed air model (three-tube system).

The theory of operation of all three models is basically the same; they weigh the JP-5 in the tank and indicate the amount in gallons. They are in reality a frictionless-balance which is hydrostatic in operation and is based on the U-tube principle. There are no floats, gears, diaphragms, springs, electrical components, or other moving parts; therefore, there is no loss of accuracy over years of use.

The U-tube is more nearly perfect than any other pressure measuring device, being free from all moving mechanical parts which can wear or lose their adjustments. The hydrostatic head of JP-5 being measured is exactly balanced by the rise of the gage liquid. Accuracy of one-half of 1 percent can be obtained with the liquid level indicators. The accuracy of the reading depends on the following four factors:

1. Proper gage installation.
2. The accuracy with which the gage scale is graduated.
3. The specific gravity used to calibrate the scale.
4. The degree of care with which the operator takes readings.

To understand the operation of the liquid level indicators, one must understand the following two principles:

1. Volume changes due to rise or drop in temperature.
2. Weight does NOT change with temperature variations.

EXAMPLE: At 60° F, 1 gallon of JP-5 weighs 6.870 pounds, and occupies 231 cubic inches. At 90° F, 1 gallon of JP-5 weighs 6.870 pounds, but expands to occupy 234 cubic inches.

The scales are calibrated in feet and inches of height of the tank and in gallons for each foot increase of tank height. The scale graduated in feet and inches is based on the MEAN specific gravity of JP-5 at 60° F. JP-5 specific gravity varies from 0.788 to 0.845. The MEAN is 0.8165. The error of readings resulting from the fluid in the tank having a specific gravity of 0.788 or 0.845 will be plus or minus 3.5 percent.

The pressure created by the height of the liquid in the tank (the hydrostatic head), acting against the air trapped in the tank downpipe, is transmitted through the pressure line to the indicating liquid in the liquid well. This pressure, being applied to the top of the indicating liquid, forces the liquid down in the liquid well (reservoir) and up into the gage glass where the reading is taken. The result is, in effect, a frictionless-balanced scale, where the unknown weight of the liquid (the hydrostatic head) in the tank is exactly balanced against the known weight of the liquid in the U-tube.

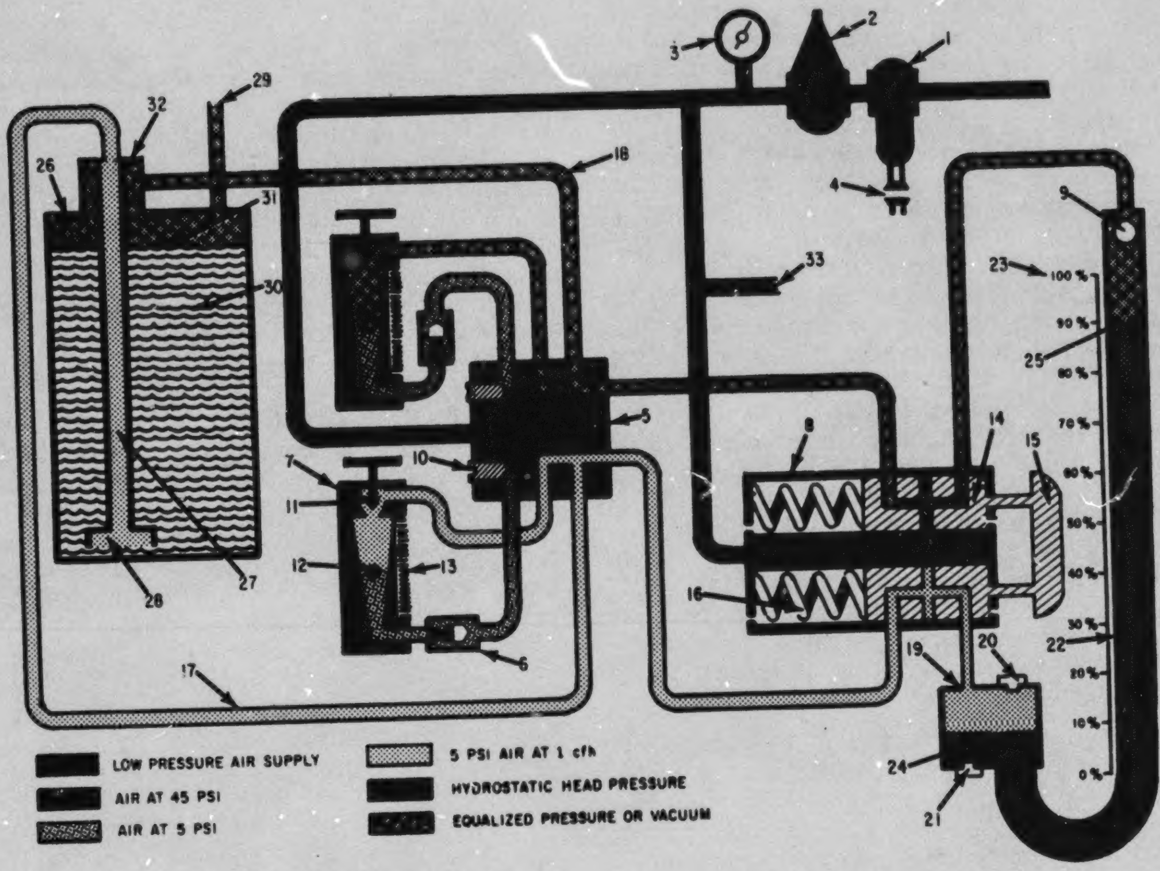
Since the theory of operation of all three models is basically the same, only the compressed air model (two-tube system) will be discussed in this chapter.

Compressed Air Model (Two-Tube System)

The compressed air model operates on a continuous supply of low-pressure air from the ship's compressors. (See fig. 6-4.)

The air supply line leading off the ship's low-pressure air system to the gage panel board contains an air filter and separator (1), an air reducing valve (2), and a pressure gage (3). This line also supplies air to other gage panels in the system.

The air filter and separator filters out dirt and separates moisture and oil from the incoming air. It contains a renewable filter element that is replaced semiannually. The separator is drained daily through the petcock (4) installed in the bottom of the air filter and separator.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20 %
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0 %
LOW PRESSURE AIR SUPPLY
AIR AT 45 PSI
AIR AT 5 PSI
5 PSI AIR AT 1 cfh
HYDROSTATIC HEAD PRESSURE
EQUALIZED PRESSURE OR VACUUM

1. Air filter and separator.
2. Air reducing valve.
3. Pressure gage.
4. Drain cock.
5. Duo-snubber manifold assembly.
6. Air check valve.
7. Rotometers.
8. Duo-purge valve.
9. Vent check valve.
10. Duo-snubber plugs.
11. Needle valve.
12. Nylon ball.
13. Scale.
14. Pistons (two).
15. Knob assembly.
16. Spring.
17. Pressure line.
18. Equalizer line.
19. Liquid well.
20. Fill plug.
21. Drain plug.
22. Gage glass.
23. Scale.
24. Indicating liquid.
25. Level of indicating liquid corresponding to 90% full.
26. Tank.
27. Tank downpipe.
28. Air bell.
29. Tank vent.
30. JP-5.
31. Level of JP-5 in tank at 90% full.
32. Tank top plug and box assembly.
33. Connection to other liquid level indicator on the panel board.

197.43

Figure 6-4.–Compressed air model (two-tube system).

The air reducing valve is a spring-loaded, diaphragm-operated valve. It is set to reduce the ship's low-pressure air to 45 psi.

The pressure gage provides a means of accurately setting the reducing valve and indicates the air pressure being supplied.

Each gage on the panel board contains the following additional equipment: a duo-snubber manifold assembly (5), an air check valve assembly (6), two rotometers (7), a duo-purge valve (8), and a vent check valve (9). The duo-snubber manifold assembly provides a compact means of interconnecting the low-pressure air supply, rotometers, equalizer line, pressure line, and the duo-purge valve. Two duo-snubber plugs (10) are incorporated in the manifold to further reduce the air pressure to the rotometers from 45 psi to 5 psi.

The air check valve assembly, located at the inlet to each rotometer, is a spring-loaded, sliding piston-type valve with a silicone rubber seat. The valves are spring-loaded to close. They allow air under pressure to flow from the duo-snubber manifold up through the rotometers during normal operation, but prevent a loss of air out of the system in the event the low-pressure air supply is cut off. They also prevent a backflow through the system during the purging operation.

The two rotometers (one in the pressure line and the other in the equalizer line) serve to meter the flow of air to 1 cfh (cubic foot per hour). Airflow through the rotometer is controlled by the needle valve (11). The rate of flow is measured by the nylon ball (12) located inside the tapered tube and a numbered scale (13) etched on the outer surface of the housing. The faster the flow, the higher the nylon ball floats on the column of air. The scale is read at the height of the nylon ball. The housing is made of clear plastic, making the ball visible.

The duo-purge valve is a two-position, spring-loaded, piston-type valve. It contains two pistons (14) working side by side in a single housing. The two pistons are connected externally to the knob assembly (15), thereby working together as a unit. The two positions of the valve are NORMAL and PURGE. Figure 6-4 shows the valve in the NORMAL position. It is held in this position by the spring (16).

In the NORMAL position, the duo-purge valve directs air from the rotometers via the pressure line (17) and equalizer line (18), to the top of the liquid well (19), and to the top of the gage glass (20).

In the PURGE position, the duo-purge valve isolates the gage from the rest of the system and directs low-pressure air at 45 psi through the pressure line, equalizer line, and tank downpipe.

The vent check valve (9) is a ball-type check installed at the top of the gage glass. It is an added safety feature that vents the gage glass and also prevents the indicating liquid from being blown out the top.

The equalizer lines and pressure lines in the compressed air model are either three-eighths or one-half inch O.D. tubing.

OPERATION OF THE COMPRESSED AIR MODEL.—The ship's low-pressure air enters the air filter and separator where it is cleaned and dried. It is then reduced to 45 psi and piped to the various gage panels in the pumproom concerned. (The rest of this operation deals with only one gage and one tank.) Clean, dry air at 45 psi enters the duo-snubber manifold assembly, where it is further reduced to 5 psi. This lower pressurized air is then directed to the inlet (bottom) of both rotometers. The flow rate through the rotometers is adjusted by the needle valve on top to 1 cfh (cubic foot per hour). Both nylon balls should be at the "1" mark on the indicating scale. (Both rotometers MUST read the same for proper operation of the valve.) It is not mandatory that they be adjusted to 1 cfh, as the gage could operate on a higher or lower flow rate, but it is a MUST that both rotometers read the same. The rotometers are normally adjusted to 1 cfh for conservation of the ship's low-pressure air. Air leaving the rotometers is directed back to the duo-snubber manifold where the rotometers are interconnected with their respective gage lines—pressure line and equalizer line. The pressure line connects the tank downpipe to the top of the indicating liquid reservoir. The equalizer line connects the top of the tank with the top of the gage glass.

It must be remembered that as long as the system is in operation, air continually flows to the tank downpipe. Resistance to this flow, caused by the static head pressure of the JP-5 in the tank, is applied to the indicating liquid in the reservoir, forcing it up in the gage glass in proportion to the amount of JP-5 in the tank. The same amount of air is also being directed to the equalizer line, equalizing any pressure or vacuum between the top of the tank and the top of the gage glass.

To purge (blow out with air) the system of dirt or moisture, depress the knob assembly on the duo-purge valve. This causes the two pistons to assume new positions. This new position causes two things to happen. First, it isolates the top of the gage glass and the top of the liquid well from the rest of the system. Second, low-pressure air at 45 psi is directed through the pressure line and tank downpipe and through the equalizer line to blow out the piping. The purge air entering the tank is vented to atmosphere via the tank vent. Any sludge that may have accumulated around the air bell will be removed by the purging operation.

Gems Tank Level Indicating (TLI) Systems

The three models of liquid level indicators (King gages), previously described are slowly being replaced with the Gems tank level indicating (TLI) system. The Gems (TLI) system consists essentially of a transmitter, magnet-equipped float, jumper cables, and a receiver. See figure 6-5 for the basic diagram of the Gems (TLI) system. Figures 6-6(A) and 6-6(B) illustrate the essential components of the TLI system.

The transmitter is the liquid level detector (or sensor). It is mounted vertically within the tank by either brackets or flanges. The magnet-equipped float houses the transmitter and moves either up or down depending on the level of fuel within the tank. A voltage divider network is located inside of, and extends the full length of, the transmitter. The voltage divider network is comprised of magnetic reed tap switches, tapped in at one-inch intervals which are connected in turn, through series resistances, to a common conductor and through high-pressure cables and connections (jumper cables) to the indicating meter in the primary receiver. The ends of the voltage divider are connected to the power supply output, which is

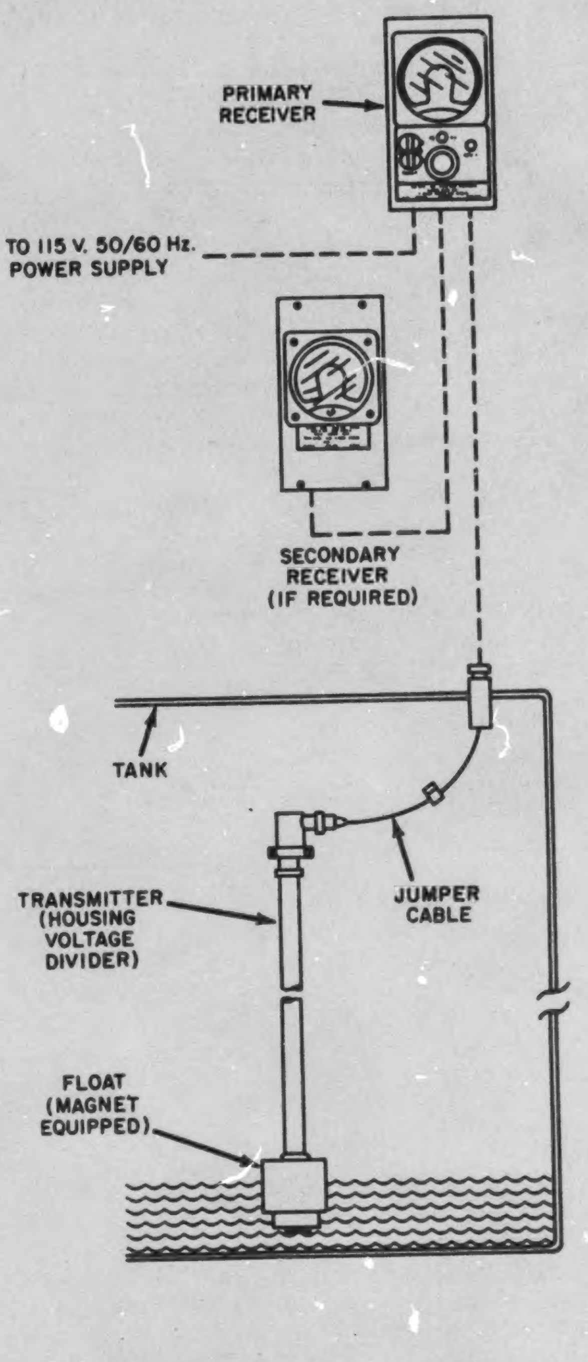

PRIMARY RECEIVER
TO 115 V. 50/60 Hz. POWER SUPPLY
SECONDARY RECEIVER (IF REQUIRED)
TANK
TRANSMITTER (HOUSING VOLTAGE DIVIDER)
JUMPER CABLE
FLOAT (MAGNET EQUIPPED)
198.103

Figure 6-5.—Basic diagram of the TLI system.

adjusted to 10 volts dc by the calibrate potentiometer in the primary receiver. The basic principle of operation is illustrated in fig. 6-7.

The transmitter assembly may be a single unit, or a number of units connected together, depending on depth and shape of the tank being gaged. Figure 6-8(A) shows two transmitters being used to gage a tank. Figure 6-8(B) is a schematic showing the location of the switches inside the two transmitters.

The magnet-equipped float moves up and down the transmitter as the liquid level changes within the tank. As the float moves, the magnetic field pattern of the float operates the tap switches. The tap switches are so arranged inside the transmitter that voltage drops are read at the receiver for each half-inch of float travel.

The primary receiver is connected to the transmitter by the cable system. Since the receiver meter indicates the voltage drop from the bottom of the voltage divider to the point of tap switch closure, the receiver readings will correspond directly with the liquid level within the tank being gaged.

When transmitters are connected in multiples (two or more), they should be mounted with a vertical overlap relationship of 9 inches so as to function as a single long transmitter (fig. 6-8(A)). This overlap physically locates the highest tap switch of the lower unit on the same level as the transfer switch, and permits both floats to rise together with liquid level over a short distance. The one-inch spacing between tap switches and the one-half inch interval between effective level meter readings render the two or more units as one continuous transmitter. All except the bottom transmitter are equipped with a transfer switch. (See fig. 6-8(B).)

The transfer switch is held closed when its float is at the bottom limit. As this float moves upward with the liquid level, the transfer switch opens to disconnect the tap switches in the next lower unit. This transfer switch action is required to open the common conductor circuit to the lower transmitter tap switches, the uppermost of which is held closed by its float at the top travel limit.

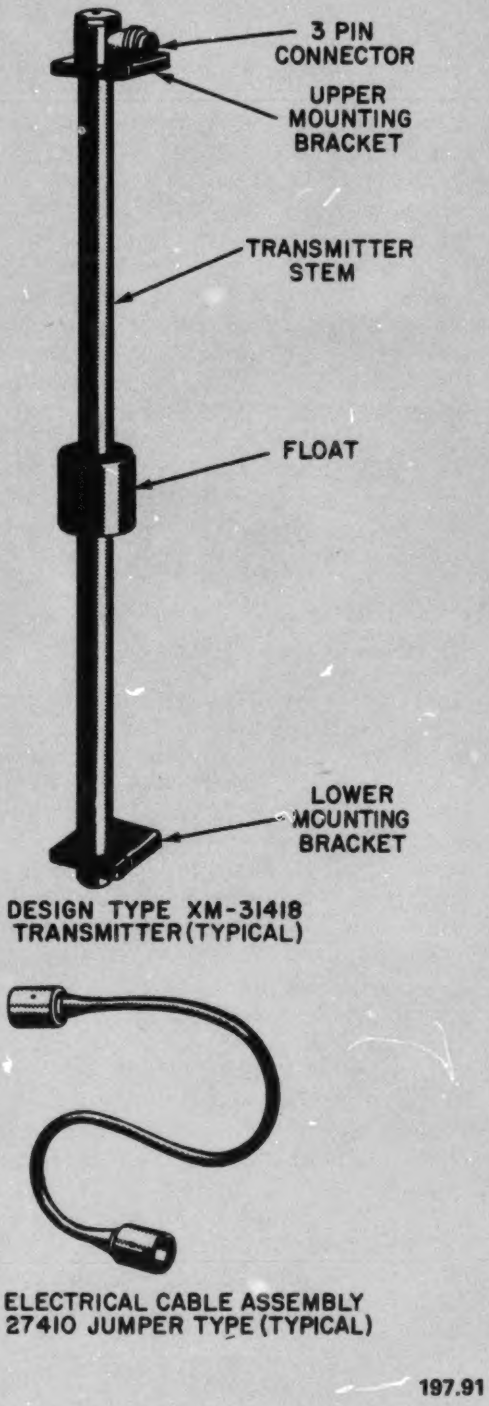
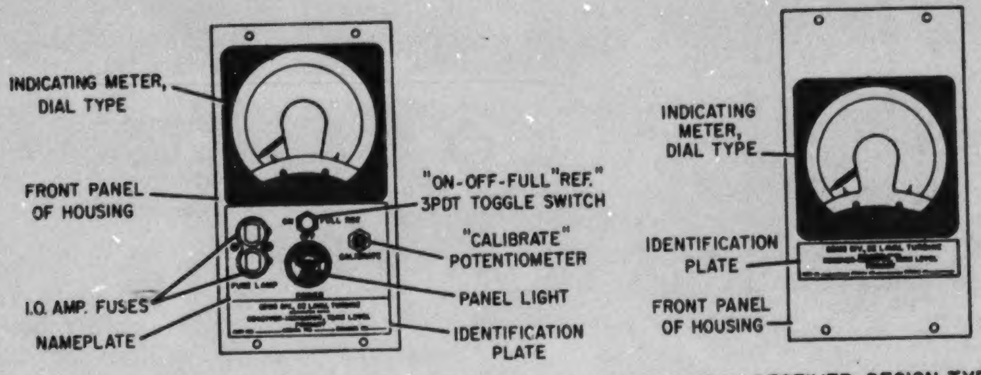
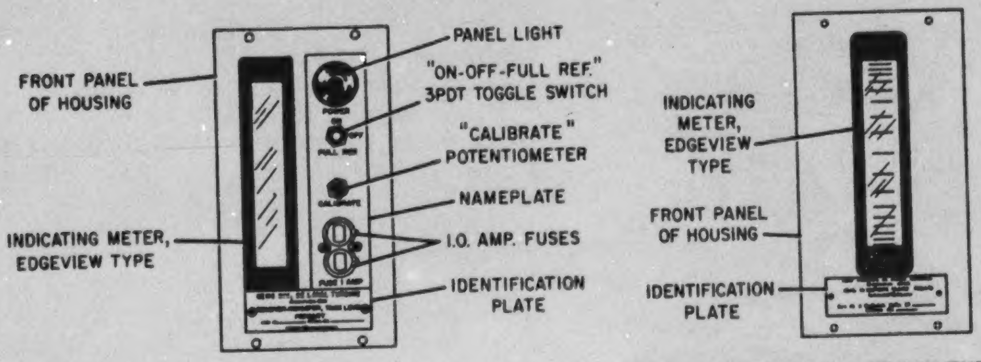

3 PIN CONNECTOR
UPPER MOUNTING BRACKET
TRANSMITTER STEM
FLOAT
LOWER MOUNTING BRACKET
DESIGN TYPE XM-31418 TRANSMITTER (TYPICAL)
ELECTRICAL CABLE ASSEMBLY 27410 JUMPER TYPE (TYPICAL)
197.91

Figure 6-6(A).—Typical TLI system components.


INDICATING METER, DIAL TYPE
FRONT PANEL OF HOUSING
"ON-OFF-FULL"REF." 3PDT TOGGLE SWITCH
"CALIBRATE" POTENTIOMETER
PANEL LIGHT
I.O. AMP. FUSES
NAMEPLATE
IDENTIFICATION PLATE
INDICATING METER, DIAL TYPE
IDENTIFICATION PLATE
FRONT PANEL OF HOUSING

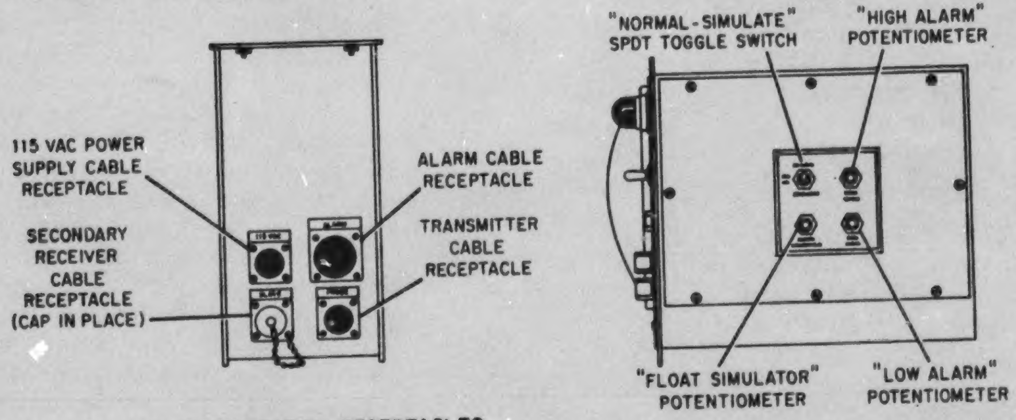
PRIMARY RECEIVER, DESIGN TYPE RE-31320

SECONDARY RECEIVER, DESIGN TYPE RE-31330


PANEL LIGHT
FRONT PANEL OF HOUSING
"ON-OFF-FULL REF." 3PDT TOGGLE SWITCH
"CALIBRATE" POTENTIOMETER
NAMEPLATE
INDICATING METER, EDGEVIEW TYPE
I.O. AMP. FUSES
IDENTIFICATION PLATE
INDICATING METER, EDGEVIEW TYPE
FRONT PANEL OF HOUSING
IDENTIFICATION PLATE

PRIMARY RECEIVER, DESIGN TYPE RE-31360

SECONDARY RECEIVER, DESIGN TYPE RE-31370

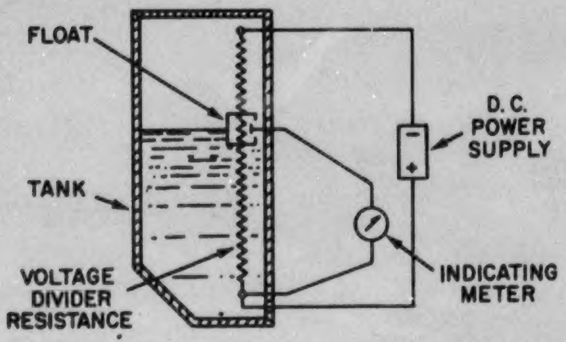

"NORMAL-SIMULATE" SPDT TOGGLE SWITCH
"HIGH ALARM" POTENTIOMETER
115 VAC POWER SUPPLY CABLE RECEPTACLE
ALARM CABLE RECEPTACLE
TRANSMITTER CABLE RECEPTACLE
SECONDARY RECEIVER CABLE RECEPTACLE (CAP IN PLACE)
"FLOAT SIMULATOR" POTENTIOMETER
"LOW ALARM" POTENTIOMETER

CABLE CONNECTION RECEPTACLES, BOTTOM OF PRIMARY RECEIVERS

SIDE PANEL (REMOVABLE) OF PRIMARY RECEIVERS

198.1[illegible]5

Figure 6-6(B).–Typical TLI system components.



197.92

Figure 6-7.—Basic principle of operation.

The primary receiver has a connection for a secondary receiver when required. The secondary receiver, when installed, is used as an additional remote level indicating station and contains an indicating meter only. See figure 6-6(B) for the two types of primary and secondary receivers. The two types of receivers differ only in the types of indicating meters used; one has a dial face and the other has an edge view meter.

Included in the primary receiver housing, in addition to the indicating meter, are the dc power supply, electrical slosh dampening control, and all system and alarm controls.

ON-OFF-FULL REF. TOGGLE SWITCH.—This switch operates as follows to control both the ac input to the power supply, and the indicating meter circuit:

Toggle in ON position (normal operation)	115 volts, 50/60 Hz applied to the power supply. Indicating voltmeter connected through series resistance to the transmitter tap switches.
Toggle in OFF position	Power supply line and indicating meter circuits are open. System is off.
Toggle in FULL REF. position (must be held in this position)	AC line voltage applied to power supply. Indicating meter is connected across entire transmitter voltage divider and cabling for system calibration.

RECEIVER CALIBRATION.—Figure 6-6(B) shows the calibrate adjustment screw. With all electrical circuits connected and the float simulator switch in the normal position, turn the calibrate potentiometer screw to the full counterclockwise position. Move the ON-OFF-FULL REF. switch to the FULL REF. position and hold while adjusting the calibrate potentiometer screw clockwise until the indicating meter reads that the tank is full. Lock the calibration potentiometer to prevent the setting from being altered. Move the switch to the ON position and the system is in operation.

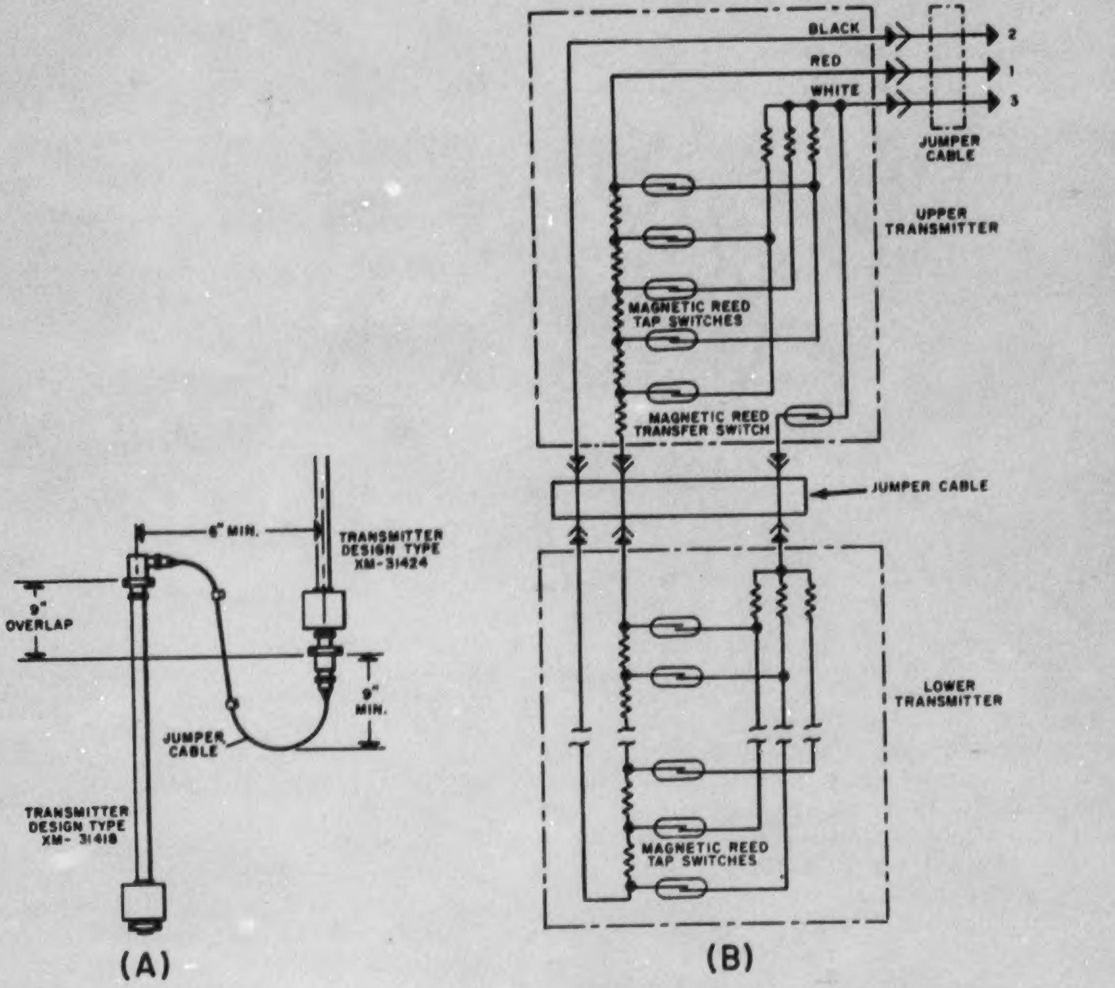
ELECTRICAL SLOSH DAMPENING.—To prevent meter fluctuation as a result of erratic float movement caused by sloshing of fuel in the tank, a capacitor is connected across the indicating meter to delay response of the meter to the transmitter signal.

ALARM CONTROL SYSTEMS.—Gems solid-state SENS-PAK alarm controls function integrally with the tank level indicating system to sense high, low, or intermediate levels of tank liquid, and actuate an alarm. The modular solid-state plug-in SENS-PAK units (fig. 6-9), may or may not be included in the primary receiver, and are actuated by voltage signals from the indicating system transmitter.

Although all primary receivers are pre-wired for a maximum of two SENS-PAK units, normally used for high and low level alarms, additional control units may be incorporated in separate housings within the same system on advice from the factory.

SENS-PAK alarm control adjustments are located on the side panel of the primary receiver and function as follows:

Refer to fig. 6-6(B) (side panel).

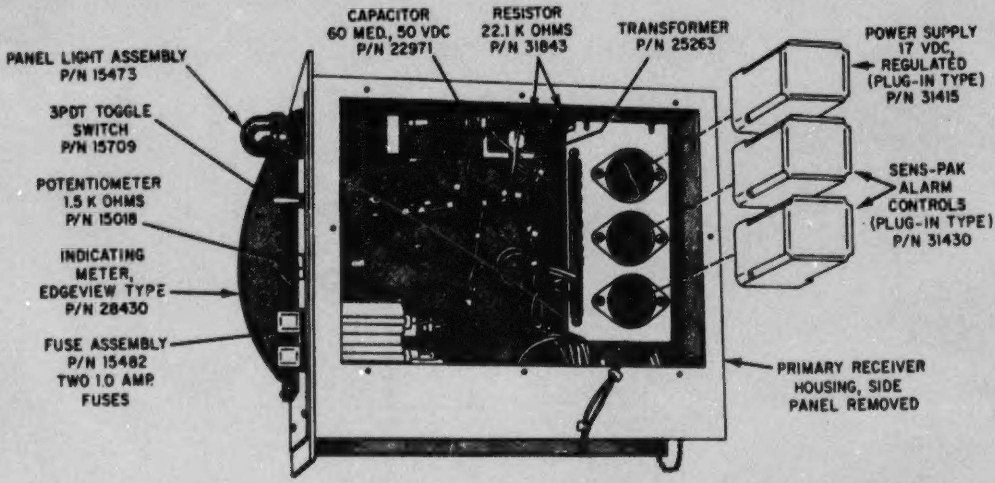

6" MIN.
TRANSMITTER DESIGN TYPE XM-31424
9" OVERLAP
9" MIN.
JUMPER CABLE
TRANSMITTER DESIGN TYPE XM-31418
(A)
BLACK
RED
WHITE
2
1
3
JUMPER CABLE
UPPER TRANSMITTER
MAGNETIC REED TAP SWITCHES
MAGNETIC REED TRANSFER SWITCH
JUMPER CABLE
LOWER TRANSMITTER
MAGNETIC REED TAP SWITCHES
(B)

198.104

Figure 6-8(A).–Multiple transmitter arrangement and mounting overlap. (B).–Multiple transmitter electrical schematic.

Switch simulate normal	Substitutes the float simulator circuit for the indicating meter circuit for alarm adjustment.
Potentiometer simulator float	Simulates the total transmitter voltage divider resistance change over the full range of float travel.
Potentiometer alarm high	Sets the actuation voltage level of the high alarm SENS-PAK.
Potentiometer alarm low	Sets the actuation voltage level of the low alarm SENS-PAK.

This system surpasses the ± 3% accuracy requirement of military specifications; however,


CAPACITOR
60 MED., 50 VDC
P/N 22971
RESISTOR
22.1 K OHMS
P/N 31843
TRANSFORMER
P/N 25263
POWER SUPPLY
17 VDC,
REGULATED
(PLUG-IN TYPE)
P/N 31415
PANEL LIGHT ASSEMBLY
P/N 15473
3PDT TOGGLE
SWITCH
P/N 15709
SENS-PAK
ALARM
CONTROLS
(PLUG-IN TYPE)
P/N 31430
POTENTIOMETER
1.5 K OHMS
P/N 15018
INDICATING
METER,
EDGEVIEW TYPE
P/N 28430
FUSE ASSEMBLY
P/N 15482
TWO 1.0 AMP.
FUSES
PRIMARY RECEIVER
HOUSING, SIDE
PANEL REMOVED

198.106

Figure 6-9.—Primary receiver interior.

the accuracy will vary depending on the size of the tank being gaged, and the type of receiver utilized.

With the ON-OFF-FULL REF. toggle switch on the primary receiver in the ON position, operation of the system, and alarms, if included, is completely automatic. Tank liquid level is read directly from the indicating meter on the primary or secondary receiver as required. No further attention is necessary, as the Gems TLI System can operate indefinitely without any component degradation. The system is safe, since currents in the transmitter circuit are so low as to be incapable of causing an explosion, even with the transmitter located in the most volatile liquids or hazardous vapors.

NOTE: The Gems systems are also approved for indicating the interface level of two liquids having different specific gravities.

CAUTION: The transmitter or receiver should not be tampered with or modified in any way other than as directed in the operation and maintenance manual.

The only maintenance that should be required at any time is an occasional cleaning of the transmitter and float when the tanks are opened for inspection and cleaning. For further information on the GEMS TANK LEVEL INDICATING (TLI) SYSTEM, refer to NAVSHIPS Technical Manual, 0965-060-1010.

STRIPPING SYSTEMS

Two systems with electric-motor-driven pumps, one forward and one aft, for stripping and consolidating the stowage tanks are installed. Two systems with hand-operated pumps, one forward and one aft, for stripping the service tanks, are also installed.

The stripping system for each JP-5 service tank is provided to remove sludge and water from the bottom of the tank. A 1½-inch line is led from a point ¾-inch above the bottom of the JP-5 service tanks to a hand-operated oscillating pump located in the associated pumproom. There is one hand-operated stripping pump in the forward pumproom serving the forward service tanks and another in the aft JP-5 pumproom serving the aft service tanks.

The stripping system for the JP-5 stowage tanks is provided to remove sludge and water from the bottom of the stowage tanks. It provides a means of consolidating the remaining fuel below the transfer tailpipes into another tank before ballasting and deballasting and when offloading fuel. It also provides a means of removing the water from the transfer filter sump tanks.

The JP-5 stowage or ballast tanks are stripped through the tank flooding and deballasting tailpipes via the tank drainage manifolds and control manifolds which are fitted for sea water flooding, deballasting, and stripping. Each control manifold is connected to the JP-5 stripping suction main.

The control manifold contains three cutout valves, one to the drainage main via a stop valve, one to a sea flooding connection via a stop check valve, and one to the JP-5 tank stripping suction main via a stop valve. All of the valves in the control manifolds are interlocked so that only one valve may be open at any one time. The body of the control manifold is connected to the body of its associated tank manifold.

The tank manifold contains a stop valve for each of the tank suction tailpipes connected to it so that the tanks may be flooded or deballasted and also that water and fuel may be stripped from the bottom of the tanks by the JP-5 stripping pumps by the proper operation of the control manifold.

The stripping pumps can discharge to the JP-5 transfer main, to the contaminated oil tanks, or overboard via the ship's main drain system eductor discharge sea chest. Stripping overboard may be done only at sea; Coast Guard regulations apply. (See "Oil Pollution Acts" covered later in this chapter.)

The stowage tanks may also be emptied by use of the ship's main drain system. The flood and drain manifolds are so arranged that the stowage tanks may be opened to this system for deballasting operations. This system is also used when removing the large amounts of sea water used in tank cleaning operations.

CAUTIONS: JP-5 carried in the stowage tanks is tested for water contamination once each week (more often if necessary) and before being transferred to the service tanks. The procedures outlined in chapter 9550 of the NAVSHIPS Technical Manual for fuel oil, such as stripping, taking thief samples, and the use of water-indicating paste, are used.

Prior to sea water ballasting of the JP-5 stowage tanks, the tanks are completely stripped of JP-5, discharging it into the transfer main instead of the contaminated oil tank. A cross connection, which is normally locked closed, is provided for this purpose. In this manner all the JP-5 is consolidated into one or more stowage tanks.

The service tanks are never ballasted. Periodic stripping of the service tanks is absolutely necessary to ensure that water-contaminated fuel is not delivered to the aircraft. Service tanks must be stripped before aircraft fueling operations or any operations involving suction from the service tanks. The hand pump should be operated until clear JP-5 is visible in the sight glass. In the event of gross contamination in the service tanks, the power stripping system may be used.

Stripping Pumps

The hand pump for the service tanks is rated at 30 gpm at 50 double strokes per minute. A stop valve is fitted at the pump suction. A sight flow indicator, a test connection, a check valve, and a stop valve are fitted in the pump discharge line. The pumps discharge overboard above the third deck.

The motor stripping pumps for the JP-5 stowage tanks are of the positive displacement type, and may be rotary vaned or gear designed. The characteristics of the JP-5 stripping pumps are as follows:

TYPE	ROTARY
Capacity	50 gpm
Total Head	50 psi
Suction	15 inches hg

Oil Pollution Acts

As a member of the aviation fuels crew performing stripping operations, you should be familiar with the provision of the Oil Pollution Act of 1924 (as amended) and the Oil Pollution Act of 1961. The 1924 Oil Pollution Act prohibits the overboard discharge of oil and water containing oil in port and in navigable coastal waters. This Act is still in effect. The Oil Pollution Act of 1961 extends the 1924 Act by prohibiting the overboard discharge of oil and of water containing oil within any prohibited zone established by the 1961 Act. The basic provision of the 1961 Act is to forbid the discharge of oil or oily water in any sea area within 50 miles of land. In addition, the 1961 Act establishes special prohibited zones which in some areas extend as far as 150 miles from land.

The penalties provided by the Oil Pollution Act do not apply when the discharge of oil or an oily mixture is required for the safety of the ship, for preventing damage to the ship or to its cargo, or for the saving of life at sea. Also, they do not apply to the accidental discharge of oil or an oily mixture if this discharge results from damage to the ship or from unavoidable leakage, provided all possible precautions have been taken to prevent the escape of oil. See chapter 12 of this training manual for further information on environmental pollution.

TRANSFER SYSTEM

The purpose of the JP-5 filling and transfer system on a CVA/CV class carrier is as follows:

1. Receive JP-5 via any of the ship's main deck filling connections for filling the JP-5 stowage tanks.
2. Transfer of JP-5 from the stowage tanks through a 200-gpm transfer filter or centrifugal purifier to the service tanks.
3. Transfer JP-5 from forward to aft and vice versa when required to change the trim of the ship.
4. Transfer JP-5 from starboard to port and vice versa when required to change the list of the ship.
5. Transfer JP-5 from the forward or aft JP-5 stowage tanks to the emergency service tanks to be used as boiler fuel in an emergency.

The JP-5 filling and transfer system has three forward transfer pumps and two or three aft transfer pumps (depending on the class carrier). All are connected to one transfer main. The transfer main is fitted with cutout valves which carry an "X" damage-control valve classification. This requires that the valves be kept closed except when open for filling or a transfer operation. All manifold valves that are connected to the transfer main also have "X" damage-control classification.

The three forward JP-5 transfer pumps are located in the forward JP-5 pumproom. The two or three aft transfer pumps are located in the aft JP-5 pumproom. The suction and discharge lines of the JP-5 transfer pumps are arranged so the pumps can draw from any JP-5 stowage tank and discharge through a transfer filter to any JP-5 service tank in a continuous, separate operation, independent of the JP-5 service pumps.

The suction and discharge headers of the JP-5 service pumps are cross-connected with the respective suction and discharge headers of the associated JP-5 transfer pump in each plant. Spectacle flanges are provided in the cross connection so that any JP-5 service pump can be used as a transfer pump in an emergency and for off loading JP-5 from the ship.

Transfer Pumps

The JP-5 transfer pumps are used to transfer fuel from stowage tanks to stowage tanks; stowage tanks to the service tanks through either a transfer filter or centrifugal purifier; and offloading fuel from the ship. They also may be used to transfer fuel to another ship under limited conditions.

The transfer pumps for use in the JP-5 transfer system are manufactured by the Blackmer Pump Company. This is a vane-type pump with a capacity of 200 gpm at 50 psi. The pump consists principally of a rotor, a cylinder, vanes, and a pressure-control valve. The cylinder is machined on a cam lathe to obtain a bore that is eccentric to the rotor axis.

The vanes, held in place by slots in the rotor, are kept in sliding contact with the bore of the cylinder by the combination of centrifugal force and bronze push rods between opposing vanes. This combination insures positive action for high volumetric efficiency. The passage of the vanes through the space between the rotor and the lower arc of the eccentric draws the liquid through the intake port and at the same time forces it out the discharge port.

A telltale drain hole is provided on the underside of each of the heads. These holes are located directly under the bearing chambers.

They are intended to serve as an indication of leakage at the mechanical seal assembly. It is normal to expect some new seals to leak very slightly until they are worn in. If excessive leaking is indicated at the drain holes, however, it is an indication that the mechanical seals should be replaced.

The pressure-control valve is provided to prevent the building up of excessive pressures which might damage the pump or associated equipment. This valve permits the liquid being pumped to flow directly from the discharge port to the suction side of the pump, should excessive pressures occur.

TRANSFER FILTER

Transfer filters (fig. 6-10) are installed as the primary means of filtering during transfer of JP-5 from the stowage tanks to the service tanks. The transfer filter operates automatically to remove entrained water and solid contaminants. The inlet piping is orificed for 150 gpm at normal operating pressure. The maximum capacity of the filters installed on most ships is 300 gpm.

The filter consists basically of a vertical pressure vessel containing expendable coalescer and separator elements mounted vertically. A swing bolted head closure, with a hydraulic jack lifting device, and a pivot are supplied for ease and speed of element replacement.

The fuel enters the inlet nozzle, flows into the inlet chamber at the bottom head, then passes through the coalescer elements mounted directly above. The solid contaminants are retained in these elements. The water, while passing through the elements, is coalesced into drops which accumulate in the sump section immediately above the element mounting plate. Separator elements are employed to divert to the sump any small droplets of water which tend to follow the fuel flow stream. The resultant water-free fuel passes through the outlet of the filter.

The filter is equipped with an automatic drain valve for scavenging the sump of water, and an automatic shutoff valve which closes off the filter outlet if water enters the sump faster than it can be drained off. A manually operated vent valve is fitted at the top outlet of the vertical vessel for venting the filter.

See chapters 4 and 5 of this training manual for details on the changing of filter elements, sampling procedures, inspections, and test for the automatic water drain controls. NOTE: All transfer filters either have been or will be replaced by centrifugal purifiers.

Centrifugal Purifiers

Two JP-5 centrifugal purifiers per pumproom have been installed on the later CVAs. The purifiers are fitted in the transfer pump discharge lines to the service tanks and serve to remove water and solids entrained in the JP-5. Each purifier is capable of handling the capacity of one JP-5 transfer pump.

The transfer pumps in each pumproom discharge to the purifiers in the same room. After passing through the purifiers, the JP-5 is discharged to the service tanks. The water and other contaminants which are removed in the purifier are discharged to a drain tank.

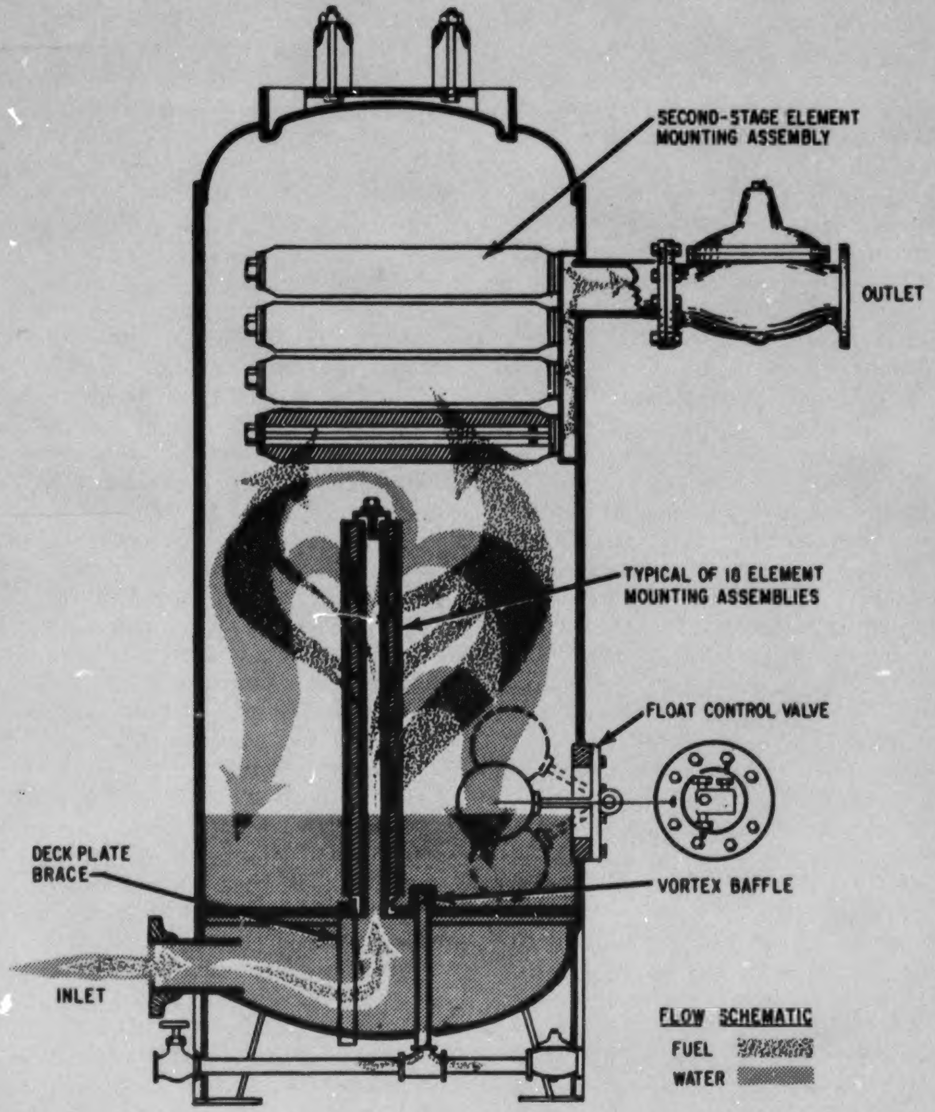
A globe valve is installed in the inlet and discharge line of each purifier.

During operation, the discharge valve is throttled to maintain back pressure on the paring disc. The back pressure should be maintained at 30 psi plus or minus 5 psi.

Should the back pressure fall below 25 psi, the purified jet fuel will pick up air; should the pressure exceed 35 psi, the paring disc chamber will overflow, the water seal will be lost, and jet fuel will discharge out through the water discharge port. The inlet valve is throttled to maintain a feed inlet pressure of 9 psi.

Before operating the centrifugal purifiers, read carefully the DeLavel technical manual NAVSHIPS 345-0453 and observe all operating instructions and precautions to prevent overheating of the purifier with the resultant possibility of a fire.

The centrifugal purifier (fig. 6-11) is a "constant efficiency" type of separator; that is, it achieves the same degree of efficiency at the end of a run as at the beginning. Accumulated solids are stored away from the separation zone; this is the reason for the constant efficiency. Separation occurs within the disc spaces, and the


SECOND-STAGE ELEMENT MOUNTING ASSEMBLY
OUTLET
TYPICAL OF 18 ELEMENT MOUNTING ASSEMBLIES
FLOAT CONTROL VALVE
DECK PLATE BRACE
VORTEX BAFFLE
INLET
FLOW SCHEMATIC
FUEL ▨
WATER ▨

198.54

Figure 6-10.—Transfer filter.

separated liquids discharge from outlets removed from the interference of the stored solids.

The efficiency and purifying ability of any centrifuge are determined by the construction and operation of the most vital part—the bowl.

Dirty JP-5 enters the top of the revolving bowl through the regulating tube. (See fig. 6-12.) It then passes down the inside of the tubular shaft and out at the bottom into the stack of discs. As the JP-5 flows up through the distribution holes in the discs, the high centrifugal force exerted by the revolving bowl causes the dirt, sludge, and water (being heavier than the JP-5) to move outward and the purified

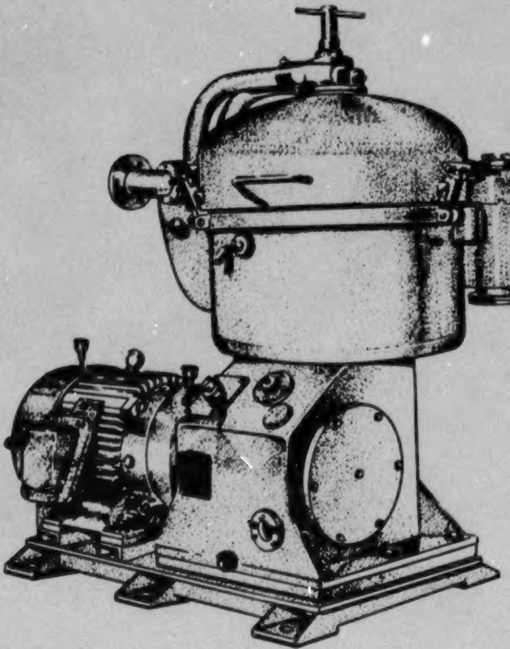


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Figure 6-11.–Centrifugal purifier.

JP-5 to move inward toward the tubular shaft. The discs divide the space within the bowl into many separate narrow passages. The liquid within each passage is restricted to flow only along this passage. This feature avoids agitation of the liquid and greatly increases the purifying efficiency.

Most of the dirt and sludge remains in the bowl and will collect in a more or less uniform layer on the inside vertical surface of the bowl shell. Water, along with some dirt and sludge, which is separated from the jet fuel, is discharged over the discharge ring at the top of the bowl top. The purified JP-5 is picked up by the paring disc which acts as a pump to carry away the JP-5.

SERVICE PUMPS

There are three to eight JP-5 service pumps, depending on the type CVA/CV class carrier serving the JP-5 aircraft fueling stations. Two or four pumps are located in the forward JP-5 pumproom, and one or four located in the aft JP-5 pumproom. The pump motors are directly connected to the pumps and are located in the same compartment.

The JP-5 system piping is arranged so that one of the service pumps in the forward JP-5 pumproom or one of the service pumps in the after JP-5 pumproom can draw from either of the service tanks associated with that pumproom.

The discharge pipes for the forward service pumps are cross-connected through a transverse header and discharge to the port and starboard risers to the forward filter rooms. The risers are again cross-connected on the third deck to allow either filter to supply both port and starboard fueling stations.

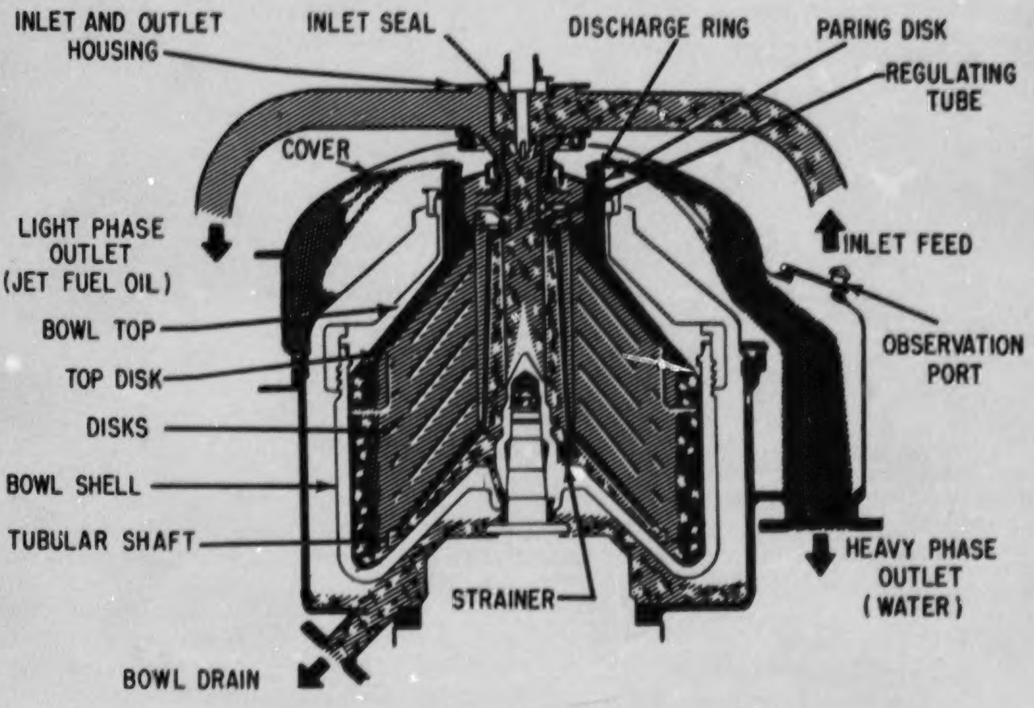
WARNING: Never allow the output from two service pumps to be directed through one main service filter. When operating one forward service pump, the discharge can be directed to either the port or the starboard filters. If necessary, either forward service pump can serve the aft quadrants via the outboard distribution piping.

The aft service pump discharges into the aft riser to the JP-5 filter. This filter supplies the aft group of JP-5 fueling stations and, through the forward and aft crossover, may supply the forward fueling stations.

In each JP-5 pumproom, the recirculating lines are so cross arranged that the recirculated JP-5 can be directed back to the same service tank from which the pumps are taking suction. Each pump recirculating line is fitted with an orifice and a stop-check valve.

The suction and discharge headers of the JP-5 service pumps are cross-connected with the respective suction and discharge header of the associated JP-5 transfer pump in each plant. Spectacle flanges and stop valves are provided in the cross connections so that any JP-5 service pump can be used as a transfer pump in an emergency and for off loading JP-5.

The service pumps used in the CVA/CV JP-5 system are of the double-suction single-stage, horizontal-shaft type. They closely resemble the Allis-Chalmers sea-water pump described in chapter 5 of this training manual. The major difference between the two is the use of


INLET AND OUTLET HOUSING
INLET SEAL
DISCHARGE RING
PARING DISK
REGULATING TUBE
COVER
LIGHT PHASE OUTLET (JET FUEL OIL)
INLET FEED
BOWL TOP
OBSERVATION PORT
TOP DISK
DISKS
BOWL SHELL
TUBULAR SHAFT
HEAVY PHASE OUTLET (WATER)
STRAINER
BOWL DRAIN

197.45

Figure 6-12.—Flow and operation of the centrifugal purifier.

mechanical seals in the pump used for JP-5. This is basically the same as the mechanical seal described in chapter 5 for use in the gasoline service pumps.

The electric motors for driving these pumps are mounted on the same base as the pump and the shafts of the two are connected by a flexible coupling.

The pumps in use at the present time are manufactured by three different companies. The pump manufacturer and the capacity for that pump are listed as follows:

1. Allis-Chalmers	1,100 gpm at 150 psi.
2. Worthington	1,000 gpm at 100 psi.
3. Warren	900 gpm at 226 feet total head.

The JP-5 pumproom deck and the service and stowage tank bottoms are on approximately the same level. When the service tank is full, this gives a positive head of liquid to the suction side of the service pump. As the JP-5 is pumped from the service tank, the head of liquid to the suction side of the pump becomes progressively lower. When the level drops below the inlet to the suction, tailpipe air can be drawn into the tailpipe and hence into the suction header. Because centrifugal pumps cannot pump air, they are not self-priming, and must have a positive head of liquid supplied to them. Some means must be made for venting or removing the air. This is done by the use of priming pumps.

PRIMING SYSTEMS

The priming system for the service pumps varies from carrier to carrier. The components used in all the systems are the same but their type of mounting and the method of control may differ.

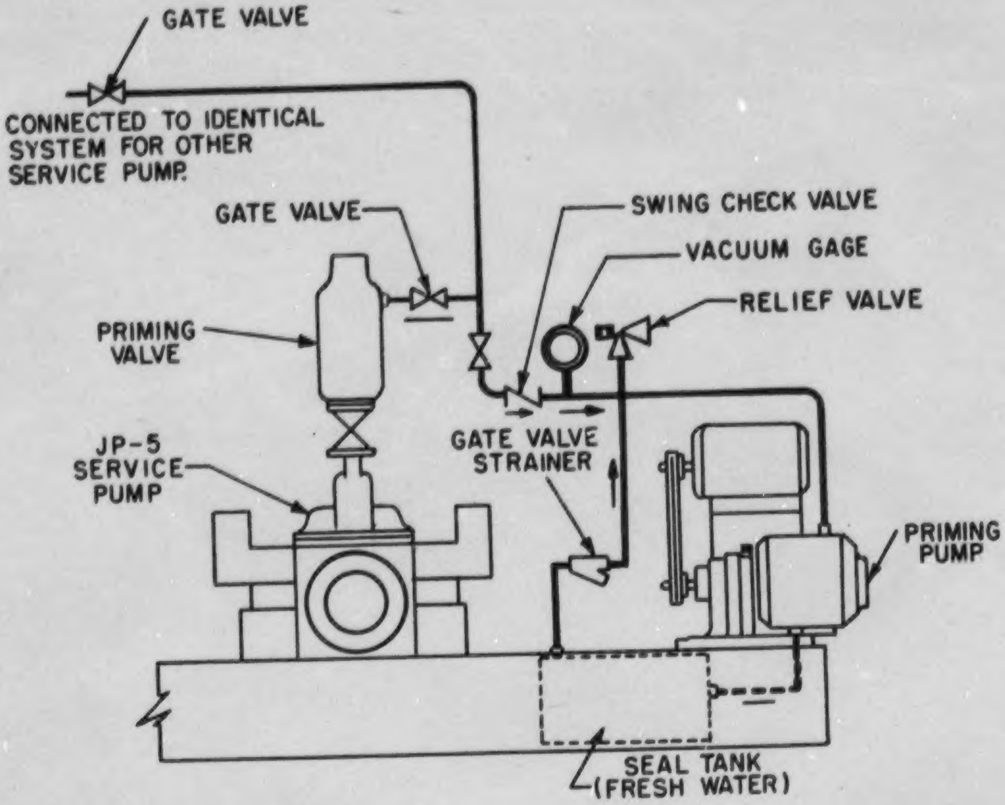
There are two types of systems on the present CVAs/CVs—a manually controlled system on some of the older CVAs and an automatically controlled system on the newer CVAs/CVs and new construction.

The JP-5 priming system (manual-type) is installed in the JP-5 pumproom for the JP-5 service pumps. The priming system consists of two motor-operated vacuum priming pumps, two recirculating seal water tanks, a float-operated priming valve mounted on each service pump, and the necessary piping and controls. (See fig. 6-13.)

The pumps and tanks are mounted on the service pump bases, and the piping is cross-connected so that one priming pump can serve more than one service pump while another priming pump is used as standby. The priming pump is started manually by using the pushbutton starting switch. When the pressure on the discharge side of the service pump is built up, a pressure-operated cutout switch will stop the priming pump. The priming pump must be manually restarted, when required.

The other type of priming pump for the JP-5 service pumps is motor-operated and mounted over the seal water tank on the JP-5 service pump base.

The controls for the priming system (automatic type) are independent of the


GATE VALVE
CONNECTED TO IDENTICAL SYSTEM FOR OTHER SERVICE PUMP.
GATE VALVE
SWING CHECK VALVE
VACUUM GAGE
RELIEF VALVE
PRIMING VALVE
JP-5 SERVICE PUMP
GATE VALVE STRAINER
PRIMING PUMP
SEAL TANK (FRESH WATER)

197.46

Figure 6-13.—Manual-type priming system.

controls for the JP-5 pumps. Each priming system consists of a vacuum tank, two motor-driven vacuum priming pumps, a recirculating seal water tank, a float-operated priming valve for each JP-5 pump and the necessary piping and controls. (See fig. 6-14.)

The automatic operation of the priming pumps is governed by vacuum switches actuated by the vacuum in the tank. One vacuum pump will act as a standby while the other is in use. The "in use" pump is set to start when the vacuum in the tank drops to 18 inches Hg and to stop at 20 inches Hg. The "standby" pump will start if the vacuum drops to 16 inches Hg and will stop when the vacuum reaches 20 inches Hg. The "in use" and "standby" services of the vacuum pumps should be alternated regularly to distribute the wear on the pumps.

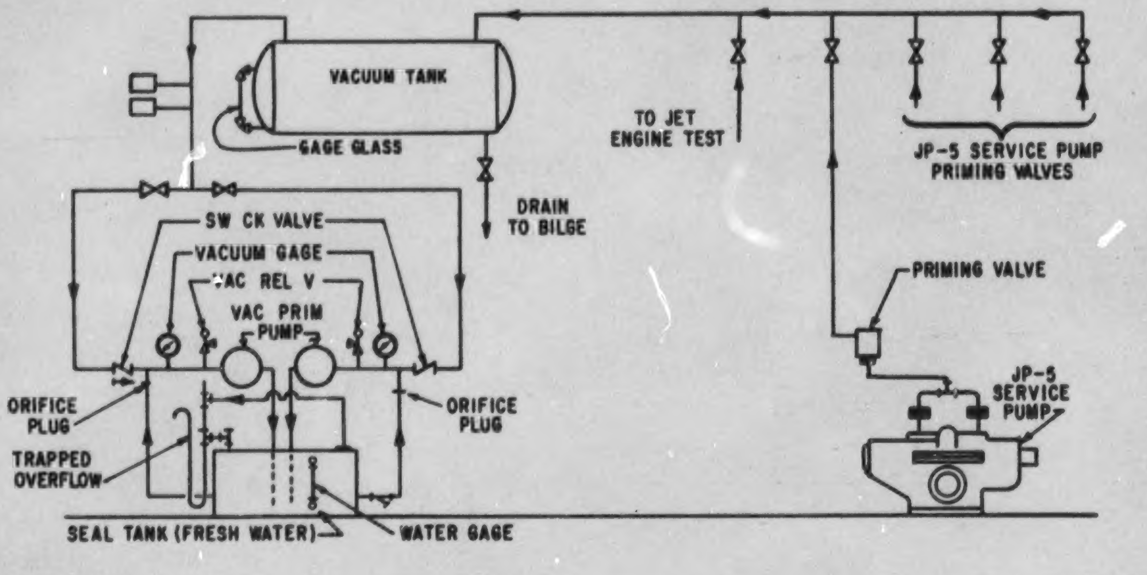
Each JP-5 service pump should be primed as a separate operation before it is started. A drain and a gage glass have been fitted on the vacuum tank. If liquid shows in the gage glass, this indicates a damaged float in the priming valve and should be checked before operating. Start up the vacuum pump in accordance with the manufacturer's instructions. The pump will stop when 20 inches Hg vacuum is obtained in the tank.

Nash Priming Pump

The priming pump is an air pump and draws air from piping connected to the topmost portion of the priming valve body. Any air that accumulates in the centrifugal pump suction line and manifold is removed through the priming valve into the priming pump.

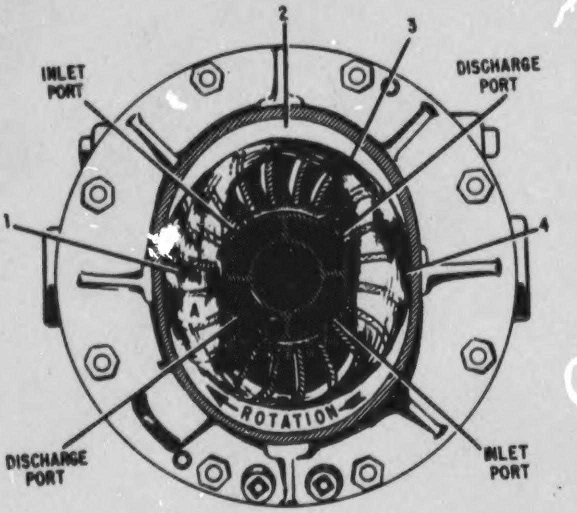
The air passing through the primer is withdrawn from the system through the priming valve as previously described with the exception of the fact that the primer suction line immediately adjacent to the pump includes a vacuum relief valve. This vacuum relief valve is provided to admit air above 22 inches of vacuum, thus keeping the horsepower consumed by the primer to a minimum. A vacuum gage shows the vacuum produced by the primer. A check valve prevents backflow of air through the primer.

The priming pumps (fig. 6-15) are centrifugal-displacement-type pumps, consisting


VACUUM TANK
GAGE GLASS
TO JET ENGINE TEST
JP-5 SERVICE PUMP PRIMING VALVES
DRAIN TO BILGE
SW CK VALVE
VACUUM GAGE
VAC REL V
VAC PRIM PUMP
PRIMING VALVE
ORIFICE PLUG
ORIFICE PLUG
JP-5 SERVICE PUMP
TRAPPED OVERFLOW
SEAL TANK (FRESH WATER)
WATER GAGE

197.47

Figure 6-14.—Automatic-type priming system.



1. Rotor.
2. Lobe.
3. Port plate.
4. Bracket.

197.48

Figure 6-15.–Interior view of priming pump.

essentially of three major parts–the rotor (1), the lobe (2), and the port plate(3). The rotor is made of a series of curved blades projecting radially from the hub. These blades, together with the side shrouds, form a series of pockets or chambers around the periphery. The lobe is elliptical in shape and forms the outer casing for the rotor. The port plate consists of two inlet and outlet ports corresponding to port surface in the rotor. These three major parts are mounted on a bracket (4) which is ported to provide the inlet and discharge connections.

The rotor revolves freely in the lobe, which is partially filled with liquid, at a speed high enough to throw the liquid out from the center by centrifugal force. This action results in a solid ring of liquid revolving in the lobe at the same speed as the rotor but following the elliptical shape of the lobe. This alternately forces the liquid to enter and recede from the chambers in the rotor at high velocity.

As the liquid is forced outward by centrifugal force, it leaves a pocket between the rotor blades into which air is drawn from the inlet port. As the rotor continues to turn, the liquid is forced inward by the elliptical shape of the lobe, compressing the air and forcing it out the discharge port.

AUTOMATIC PRESSURE REGULATOR

An automatic pressure-regulating system is installed in each JP-5 quadrant distribution riser except on carriers equipped with Cla-Val fuel/defuel valve type of service stations. The pressure regulator maintains a constant regulated pressure in the quadrant at all rates of flow. The regulating systems are identical for all class carriers except for their physical size and pressure setting. The size of the distribution riser determines the size of the regulating system required, either 6-inch or 8-inch. The pressure setting will vary for the individual ship. This will depend on the size and length of the piping in each quadrant and the type service station installed; i.e., Blackmer or Wheeler. See chapter 5 of this training manual for detailed information on the pressure-regulating system.

SERVICE FILTERS/SEPARATORS

One filter/separator is provided in each JP-5 riser to remove entrained water and solid particles from the JP-5. The filter consists of a main cylindrical shell containing coalescer and separator elements. These elements must be replaced when they become clogged. (See chapter 4 of this training manual for details on the changing of filter elements.) A water-receiving sump is incorporated in the filter. An automatic drain valve is fitted for draining the sump overboard through a 1-inch line fitted with a check valve, a sight glass, and a shell connection fitted with a steam heating coil.

The automatic drain valve is controlled by a float designed to float at the cleavage plane between the water and the JP-5 in the sump of the filter. As the sump fills with water, the float will rise and open the drain valve, allowing the water to flow overboard through a 1-inch line. When the water level drops, the drain valve will close. A small amount of water is always retained in the bottom of the sump to prevent JP-5 from entering the sump drain.

A pilot-operated stop valve is fitted in the JP-5 line at the filter outlet. This valve is also controlled by the cleavage plane float in the filter sump.

The valve is arranged to cut off the flow from the filter in the event that the water level in the sump becomes excessively high. The sampling connections are used to check the water content of the JP-5 being delivered to the fueling stations. Daily samples are taken from the filter sump. In addition, fuel samples are taken during the monthly automatic water drain and slug control valve tests, to determine if water is passing through the service filters. See chapter 4 of this training manual for details on the changing of filter elements and sampling procedures. See chapter 5 for details on inspections and tests for the automatic water drain controls.

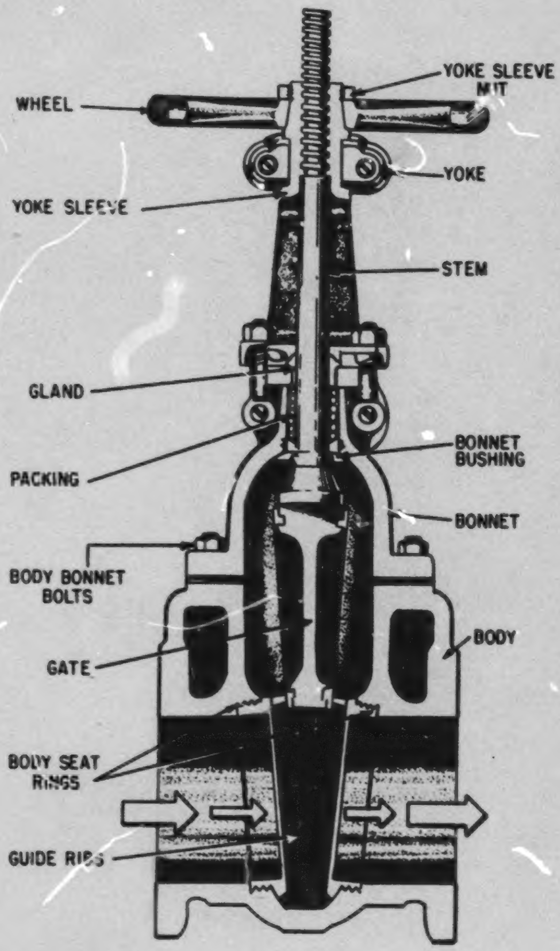
The sizes and types of mounting of the JP-5 service filters vary from ship to ship. Always check the technical manual for the service filters aboard ship for the capacity, number, and type of elements and other details.

VALVES

There are several types of valves used in the JP-5 systems. Many of the valves used in the filling and transfer system are of the gate type. Those used on the discharge side of all pumps are of the globe type. The valves used in the distribution system may be of the positive stop plug type, swing gate type, or the butterfly type. The positive stop plug valve is discussed in chapter 5 of this training manual. The swing gate and butterfly valves are discussed in the following paragraphs.

Gate Valves

Gate valves (fig. 6-16) are used where a straight flow with a minimum amount of restriction is desired. Most gate valves have a wedge-shaped gate, although some have a gate of uniform thickness. The gate is connected to the valve stem and is positioned by means of a handwheel. The port is the full size of the pipe, and extends straight through the valve.



197.49 (11.317.2)
Figure 6-16.—Gate valve.

Some types of gate valves have a rising stem, and a glance at the valve will show whether it is opened or closed. In the type of gate valve with the nonrising stem, the stem revolves in the bonnet, and the gate is raised or lowered by means of the threads on the internal end of the stem. On this type of valve, a pointer or gage is usually installed to indicate the open and closed positions.

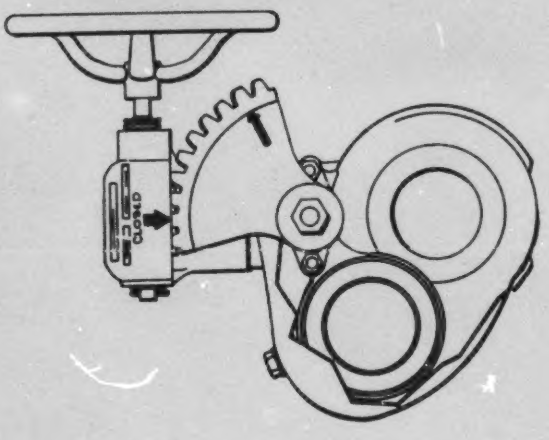
Unlike most valves, gate valves will operate properly with either face on the inlet side, thus simplifying the job of installation. Case or forged steel valves have discs and seats made of nickel-copper alloy, chromium steel, or a steel that has been treated with a hard facing material; valve stems are of corrosion-resistant steel, and the handwheels are of fabricated steel, brass, or aluminum. Bronze gate valves are made entirely of bronze except for malleable iron or aluminum handwheels.

Okadee Swing Gate Valve

The Okadee swing gate valve (fig. 6-17) is of the nonlubricated type and like all gate valves will operate properly with either face on the inlet side.

The valve body is flanged and made of bronze, while the seats are stellited nickel-plated steel. The discs have Teflon inserts to form the seal.

To operate the swing gate valve turn the handwheel counterclockwise, which will cause the gates to swing into the valve body bulge and open the ports for fluid flow. When closing the valve, the discs rotate, thus equalizing the wear on the Teflon inserts, and at the same time a ringing action occurs between them and the seat faces resulting in a tight shutoff. The valve is closed when the selector arrow and the nameplate arrow are aligned.



197.50

Figure 6-17.—Okadee swing gate valve.

NOTE: In the operation of wheel-operated valves, it is not necessary to exert excessive force as this only adds strain on the gears and stem and does not produce a tight seal. After the valve has been closed, back the wheel off until it is free; this will relieve any possible strain and add to the packing life.

Globe Valves

Globe valves are so called because of the globular shape of their bodies. It should be noted, however, that other types of valves may also have globe-shaped bodies; hence, the name is not always properly descriptive.

In a globe-type stop valve, the disc, which is attached to the valve stem, seats against a seating ring or seating surface and thus shuts off the flow of fluid. When the disc is moved off its seat, fluid can pass through the valve. Globe valves may be used partially open as well as fully open or fully closed.

Globe valve inlet and outlet openings are arranged in several ways, and are used to suit the requirements of flow.

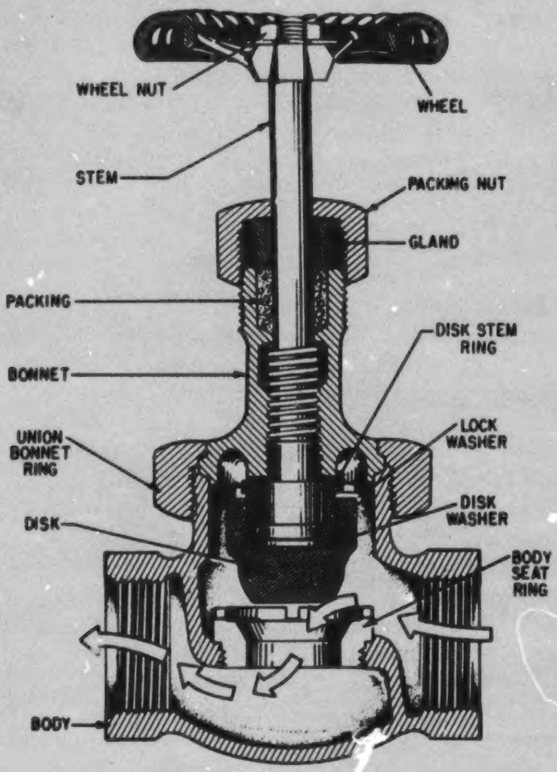
There are three common types of globe valve bodies. In the straight type, the fluid inlet and outlet openings are in line with each other. In the angle type, the inlet and outlet openings are at an angle to each other. An angle-type globe valve is used where a stop valve is needed at a 90-degree turn in a line. The cross-type globe valve has three openings, rather than two; it is frequently used in connection with bypass piping.

A cross-sectional view of a globe valve is shown in figure 6-18.

Butterfly Valve

The butterfly valve (fig. 6-19) is relatively new in the naval service, and is being used on some carriers to replace the Atwood and Morrill Company positive stop plug valves. The butterfly valve is light in weight; it takes up less space than the positive stop plug valve and is relatively easy to operate. Also, as in the gate valves, this valve will allow fluid flow in either direction.

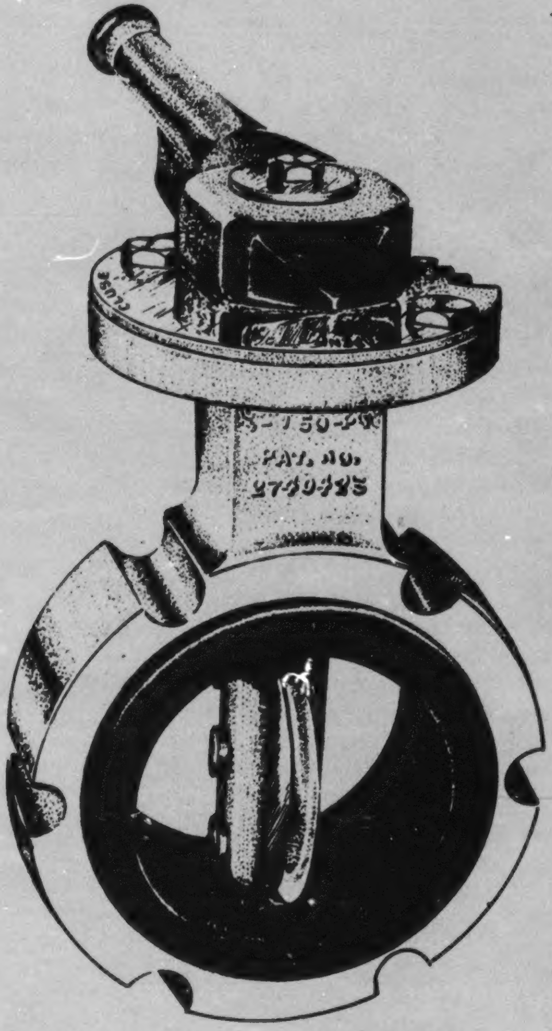
The butterfly valve consists of a body, a resilient seat, a butterfly-type disc, a stem,



197.51(11.317.1X)
Figure 6-18.—Globe valve.

packing, a notched positioning plate, and a handle. The replaceable resilient seat is held firmly in place by mechanical means; neither bonding nor cementing is necessary. It is not necessary to grind, lap, or do machine work to replace the seat, so overhaul of the valve is relatively simple. The resilient seat is under compression when it is mounted in the valve body, thus making a seal around the periphery of the disc and at both upper and lower points where the stem passes through the seat. Packing is provided to form a positive seal around the stem in the event that the seal formed by the seat becomes damaged. When closing the valve, the handle need only be turned 90 degrees.

NOTE: The resilient seat-type butterfly valve should never be used as a tank top valve or throttling valve, or where a pipe passes through a bulkhead.



197.52 (11.318X)
Figure 6-19.—Butterfly valve.

DISTRIBUTION PIPING CVA-34

The two JP-5 lines leaving each filter room are piped outboard through the shell of the ship to supply the fore-and-aft distribution mains which run outside of the shell. One of the lines from each filter room supplies a main running forward and the other main running aft. All JP-5 piping outside of the ship below the main deck level and in other exposed locations is protected by a nontight U-shaped plating guard.

On the portside, the main running aft from the forward filter room is connected to the main running forward from the after filter room, so that JP-5 can be transferred between the forward port and the after port quadrants.

The port and starboard distribution piping is connected by a cross connection between the filter rooms forward. The cross connection makes it possible to deliver JP-5 to any JP-5 fueling station on the ship from any JP-5 service pump or filter.

Two cutout valves are fitted between the main from the forward port filter room and the main from the after port filter room. A valved vent and a valved drain are provided between these two valves. A length of 1½-inch rubber hose fitted with a nozzle valve is attached to the vent connection which allows the displaced JP-5 to be directed into a safety can.

Risers are run from the fore-and-aft distribution mains to supply the JP-5 fueling stations. One riser is provided for each fueling station.

Associated with the distribution system is the defueling piping. The defueling piping is used to route JP-5 from the fueling station back to the stowage tanks. There are two JP-5 defueling mains which penetrate the shell from each JP-5 filter room. The mains then run forward and aft with risers to the defueling pump discharge in each station. The outboard defueling piping runs parallel to the distribution piping and in most cases under the same protective plating. The outboard defueling mains, port forward, join in the forward port filter room and continue down to the forward JP-5 pumproom. The outboard defueling mains, starboard forward, join in the starboard forward filter rooms, and continue down to the forward JP-5 pumproom. Both port and starboard defueling mains are connected to the transfer pump suction header in the forward JP-5 pumproom.

The outboard defueling mains, port aft, join in the aft port filter room and continue down to the fourth deck and connect to the after filling crossover.

FUELING STATIONS

The JP-5 fueling stations vary in location and number between the different classes of carriers. The newer carriers have the Cla-Val (automatic fuel/defuel valve) type stations. The older carriers have the Blackmer or Wheeler type of fueling stations, though some have converted to the Cla-Val station. The Wheeler type is described in chapter 5 of this training manual.

The following is a brief description of the operating characteristics of the Blackmer and Cla-Val fueling stations.

BLACKMER FUELING STATION

At each aircraft fueling station there are two fueling pumps driven by a common motor and a hose for each pump for servicing aircraft. The pumps are driven at a constant speed in one direction, but their suction and discharge ports are controlled through individual four-way valves so that they can either take suction from the distribution main and deliver to the aircraft hose for fueling the aircraft, or take suction from the hose. This latter setting is used to empty the hose after use. The fueling setting of the four-way valve is made by completing the electrical grounding of the hose nozzle and operating a lever. The hose-emptying cycle is automatically set whenever the electrical circuit is broken.

In order to make possible the emptying of the hoses after use and when the system is under pressure for delivery operations, the pressure in the supply main at the aircraft fueling stations must be kept below 20 psi. The pressure at the service pumps must be greater than this limit in order to deliver the full capacity to the more remote stations, and this pressure would not be greatly reduced by gravity if none of the aircraft fueling stations were fueling; therefore, it is necessary to throttle the flow to maintain a constant pressure at the fueling stations. All this is accomplished by the automatic pressure regulator previously described. The valve partially closes and reduces flow when the demand is small, and opens and increases flow when the demand is large. This arrangement is designed to regulate the flow so that the pressure will be about 20 psi at the filter outlet and about 20 psi maximum at any fueling station at all rates of flow, with at least 5 psi at the most remote station at the maximum rate of flow. This condition will apply when the most remote aircraft fueling stations forward and aft are operated simultaneously or individually.

It should be noted that all Blackmer fueling stations used in the JP-5 systems have been altered by removing the priming system. The fuel pump casing pipe plugs were fitted with a valve connection, pet cock, and a short length of tubing for venting the station. These components were added to permit collection of escaping JP-5 into a safety can or other suitable receptacle since it is considered a potentially hazardous condition when venting directly from the pipe plugs.

NOTE: This alteration applies only to Blackmer stations within the JP-5 system; it has no affect on Blackmer stations within the AvGas system.

Cla-Val Fueling Station

The JP-5 Cla-Val station described here is identical to the AvGas Cla-Val station except that it has a higher capacity. The newer carriers (e.g., *Forrestal)* have two- and four-hose stations. The older carriers that have been converted to the Cla-Val station have only two-hose stations.

Each two-hose fueling station consists of two solenoid-operated, pressure-regulating, fueling-defueling valves, one defueling pump, 2½-inch collapsible hose for fueling only, and a 2½-inch noncollapsible hose for fueling and defueling. When not in use, the collapsible hose is stored on a hand-operated hose reel, and the noncollapsible hose is on a motor-driven rewind hose reel.

Each four-hose fueling station consists of four solenoid-operated, pressure-regulating, fueling-defueling valves, one defueling pump, three reels of 2½-inch collapsible hose for fueling only, and one reel of 2½-inch noncollapsible hose for fueling and defueling. When not in use, the three collapsible hoses are stowed on a hand-operated hose reel and the noncollapsible hose is stowed on a motor-driven rewind hose reel.

The motors for the defueling pumps on the hangar deck (main deck) are explosion proof and/or spray tight. The motors on the gallery deck are of the explosion-proof type and/or spray tight. The motors for the defueling pumps on the gallery walkway are of the spray-tight type.

The solenoid fueling-defueling valve is in the defueling position when the solenoid is deenergized. With the solenoid energized, the valve is in the fueling position until the solenoid is deenergized, which automatically returns it to the defueling position. The solenoid is energized from the low voltage control circuit through a magnetic amplifier which permits the flow of current to the solenoid as long as the low voltage circuit through the fueling hose to ground is complete. A switch near the fueling nozzle gives the operator control over the fueling and defueling operations. An interruption in the electrical circuit or break in the electrical ground connection to the aircraft will automatically return the valve to the defueling position. Magnetic amplifiers eliminate the possibility of sparks occurring when the low voltage control circuit is interrupted.

At each fueling station unit it is possible to defuel one aircraft with the defueling pump and hose while the other hose is fueling another aircraft. In order to defuel the tanks of an aircraft, it is recommended that fuel be supplied to the aircraft tanks for 12 seconds to prime the hose line before shifting the fueling-defueling valve to the defueling position.

JP-5 SUPPLY TO JET ENGINE TEST STAND

On the newer CVAs/CVs there is a JP-5 supply to the jet engine test stand. This is a system in itself, having a separate pump, filter, and controls.

A supply of JP-5 is provided to the jet engine test stand on the main deck aft for testing jet aircraft engines. The JP-5 is supplied by the jet engine test stand pump located in the aft JP-5 pumproom. The pump takes suction from the JP-5 service pump suction header and discharges to the engine service stand.

A 1¼-inch recirculating line, fitted with a stop check valve and an orifice, is taken off the pump discharge and is led to the JP-5 service pump recirculating header.

A filter is fitted in the JP-5 supply line to the engine service stand. The filter is similar in construction and piping arrangement to the JP-5 service filters previously described. From the filter outlet, the JP-5 passes through a solenoid-operated valve to the test stand. The solenoid-operated cutout valve fitted in the supply line to the test stand may be operated from the adjacent jet engine control room.

A back pressure control valve is installed in the return line from the test stand and is set to maintain 30 psi at the test stand under all flow conditions.

LPH 2
JET FUELS SYSTEMS

The LPH was developed specifically to support the vertical envelopment phase of amphibious assault landings. The JP-5 system is similar in many respects to the CVA/CV JP-5 systems. Most of the components in the system are identical though they may be arranged in the system somewhat differently.

GENERAL DESCRIPTION

JP-5 is used primarily for fueling of turbine-powered helicopters. It is also used as fuel for the emergency diesel generators and for the inert gas generator. JP-5 may be used as fuel for the boilers in case of an emergency or for starting up cold boilers.

This system provides for the transporting of JP-5 to and from the JP-5 stowage tanks, the JP-5 service tanks, and the JP-5 fueling stations with a maximum of safety.

JP-5 is pumped into stowage tanks by using either the port or the starboard filling connections and the filling and transfer piping.

JP-5 must be pumped by the transfer pumps through the JP-5 transfer centrifugal purifiers to the JP-5 service tanks before fueling operations. Two JP-5 service pumps take suction from the service tanks and provide sufficient pressure to deliver fuel at the fueling stations on the hangar deck, the gallery deck walkway, and the flight deck.

Each JP-5 fueling station is supplied with an electric-motor-driven defueling pump and two reels with hoses for fueling and defueling. The defueling pump takes suction from the discharge side of the fuel-defuel valve and discharges to the JP-5 defueling main. The fueling setting of the fuel-defuel valve is made by grounding the hose nozzle and operating the toggle switch on the switch housing. The defueling and hose-emptying cycle is set automatically whenever the electrical circuit is broken.

Unless repairs are necessary, the JP-5 system must be maintained full of JP-5 at all times.

JP-5 stowage tanks are normally used for stowing JP-5 prior to transfer to the JP-5 service tanks. JP-5 from these stowage tanks may be transferred to other JP-5 stowage tanks. Stowage tank manifolds are located in the JP-5 pumproom.

JP-5 SERVICE PUMPS

These pumps are used to transfer JP-5 from the JP-5 service tanks to the helicopter fueling stations, the emergency diesel generator tanks, the inert gas generator tank, or to another ship.

There are two JP-5 electric-motor-driven service pumps rated at 220 gpm at 90 psi and located in the JP-5 pumproom. Either of the two pumps can take suction from either service tank and can discharge to any hangar deck or flight deck JP-5 fueling station by way of the third deck distribution main. The service pump discharge header is cross-connected to the transfer pump discharge header in order that the service pumps may be used for offloading JP-5. The systems are isolated with closed pipe blinds.

The discharge piping from these pumps is fitted with a recirculating line to the service tank from which JP-5 is being taken. This line is installed to prevent overheating of the service pump during zero demand and is orificed to allow flow of approximately 11 gpm.

The pumps are equipped with a timing relay switch and a pressure switch, so that if they fail to discharge fuel at 20 psi or more within 3 minutes after starting, the pumps will shut off automatically. Also, while the pumps are running, if the discharge pressure drops below 15 psi, the pumps will be shut off by the pressure switch.

Priming System

The priming system ensures that the JP-5 service pump casings and stowage tanks manifolds are filled with JP-5, by removing air and fuel vapors from them before pumping operations are started.

The priming system, located in the JP-5 purifier room, consists of one vacuum tank designed to operate at 14 to 22 inches of mercury, and two priming pumps. One of the pumps is a standby for the other.

The suction line of the priming pump is connected to the vacuum tank, which in turn is connected to the top of the housing of each of the JP-5 service pumps and to each of the JP-5 stowage tank manifolds. One float-operated priming valve is located above the two service pumps and one is located above the stowage tank manifolds. The float-operated priming valves are isolated from the manifolds by globe valves. (See fig. 6-20 for a typical arrangement of the LPH priming system.)

JP-5 TRANSFER PUMPS

These pumps are used to transfer JP-5 from the JP-5 stowage tanks through the JP-5 centrifugal purifiers to the JP-5 service tanks, or from stowage to stowage tank, or to transfer JP-5 to another ship. In case of an emergency, the pumps are used to transfer JP-5 from stowage tank to fuel-oil service tanks, for use in the boilers.

There are two motor-driven transfer pumps, rated at 200 gpm at 50 psi and located in the JP-5 pumproom.

The transfer pump discharge piping is fitted with a bypass to the JP-5 centrifugal purifier, and piping is arranged so that either transfer pump may supply either purifier which discharges to either service tank.

CAUTION: Centrifugal purifiers are rated at 200 gpm. Transfer pumps are

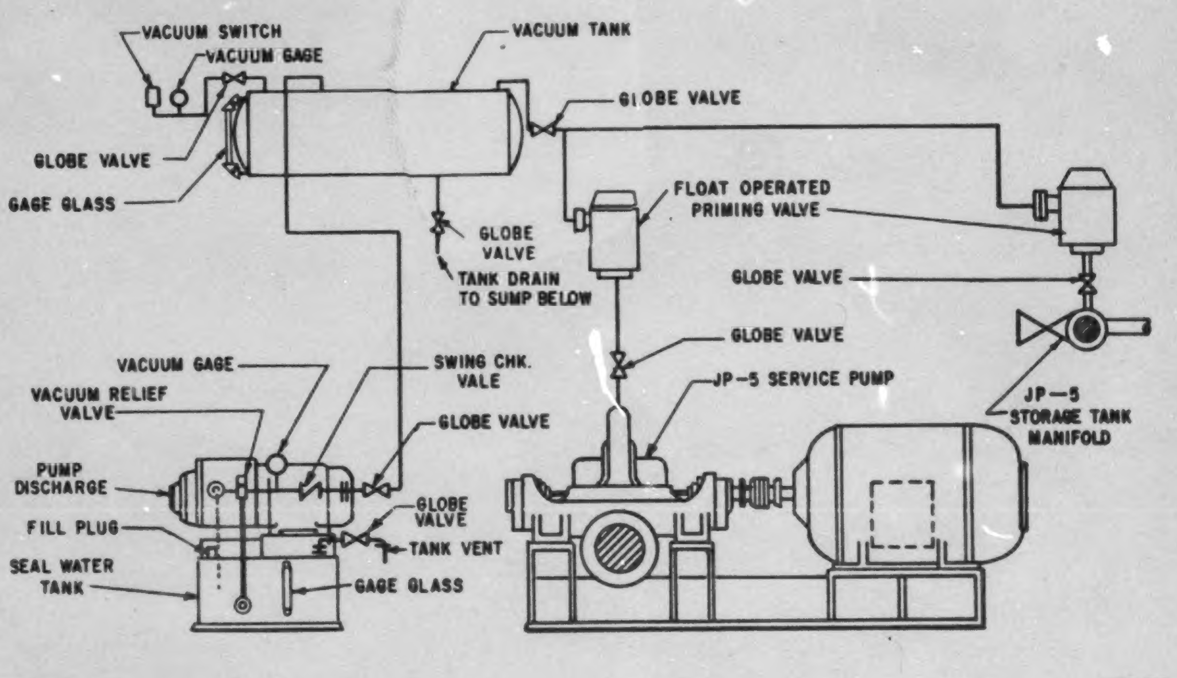

VACUUM SWITCH
VACUUM GAGE
VACUUM TANK
GLOBE VALVE
GLOBE VALVE
GAGE GLASS
FLOAT OPERATED PRIMING VALVE
GLOBE VALVE
TANK DRAIN TO SUMP BELOW
GLOBE VALVE
GLOBE VALVE
VACUUM GAGE
SWING CHK. VALE
JP-5 SERVICE PUMP
VACUUM RELIEF VALVE
GLOBE VALVE
JP-5 STORAGE TANK MANIFOLD
PUMP DISCHARGE
GLOBE VALVE
FILL PLUG
TANK VENT
SEAL WATER TANK
GAGE GLASS

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Figure 6-20.—LPH priming system.

positive-displacement type and deliver 200 gpm EACH. Discharge from TWO pumps through ONE purifier will result in maloperation of the purifier. Use only ONE pump per purifier.

The transfer pumps are piped to provide transfer capability from stowage tanks port to starboard and starboard to port. The system should be lined up to discharge fuel from the defueling main to a slack tank on one side of the ship while taking suction from the other side for purifying the service tanks. At no time should contaminated JP-5 be permitted on the discharge side of the centrifugal purifiers unless the purifiers are completely inoperative. JP-5 then may be transferred to service tanks and allowed to settle for at least 4 hours before stripping. Fuel transferred without purifying must not be used in aircraft.

The transfer pumps are positive-displacement pumps and are not connected to the priming system.

CENTRIFUGAL PURIFIERS

The LPH has two centrifugal purifiers located in a separate space–purifier room. The machinery for the priming system is also located in this space. This is the same type purifier as previously described in this chapter for use in the CVA/CV JP-5 system. (See fig. 6-11.)

The purifiers are arranged in the system so that either or both purifiers may be used. A drain tank with a capacity of 1,200 gallons is located adjacent to the purifier room. This tank can contain the entire discharge of both purifiers for a period of approximately 3 minutes before overflowing. Should the tank liquid level be observed to be rising rapidly, stop the transfer pumps and investigate the cause.

HELICOPTER FUELING STATIONS

These stations are installed for the purpose of fueling and defueling turbine-powered helicopters. Only helicopters using JP-5 may be fueled and defueled at the JP-5 stations.

The helicopter fueling stations are located on the portside of the ship on the hangar deck and on the gallery deck walkways below the flight deck.

The JP-5 fueling station is similar to the LPH AvGas station and consists of the following:

1. One positive-displacement defueling pump rated at 50 gpm at 15 psi, driven by an electric motor.
2. One 300-gpm filter/separator.
3. Two automatic fuel/defuel valves–one mounted on the inlet side of each hose reel.
4. Two hand-operated hose reels with 1½-inch hard hose.
5. The valves, controllers, and pushbuttons necessary for operating the station.

The motors used in stations on the hangar deck are explosion proof while those in the gallery deck walkway stations are spray tight.

A riser from the distribution main supplies JP-5 to each aircraft fueling station.

JP-5 that has been taken from the aircraft by the defueling pump is discharged into a separate 2-inch line and routed back into the stowage tanks.

Each fueling valve and each hose reel must have a positive electrical ground connection to the ship's structure. An electrical circuit from the amplifiers is carried through a 1-inch thick gasket installed between the flange at the inlet of the hose reel and the pipe flange of the pipe which carries the fuel from the fueling valve to the hose reel. From the 1-inch gasket, the electrical contact is continued to the center of the hose connection on the drum of the hose reel.

Each length of hose has a wire fabricated into it in such a way as to maintain electrical contact when two or more hoses are coupled together. Each aircraft fueling hose reel contains three 50-foot lengths of hose.

JP-5 OPERATING PROCEDURES

Operating diagrams and instruction boards are mounted in each JP-5 pumproom. Operating instructions are also mounted at each aircraft fueling station. These operating instructions give detailed procedure for performing various operations. Operating personnel should familiarize themselves with the chart and refer to it when operating the system.

The procedures applicable for fueling jet aircraft on carriers having automatic fuel-defuel valve type stations are as follows:

1. Line up the distribution system to take suction from the proper JP-5 service tank and to deliver to the fueling stations through the filter.

2. For each JP-5 service pump to be placed in operation check that the discharge valve is closed. Open the stop valve in the priming line from the float valve to the priming pump (or to the priming system) to be used. Open the recirculating valve, and open the valve in the recirculating line to the service tank from which suction is being taken. Open all valves on the suction side of the service pump to the service tank. Start the priming pump, then start the service pump. When the discharge is built up, slowly open the discharge valve. One JP-5 service pump will normally supply about five hoses simultaneously.

3. Line up the defueling riser to discharge, via the filling and transfer main, to a slack JP-5 stowage tank.

4. Vent the filter until fluid appears in the filter vent sight glass.

5. Start the fuel station defueling pump.

6. Circulate a sufficient quantity of JP-5 (2 minutes max) to the JP-5 defueling main in order to purge the service system on the discharge side of the filters of condensed water vapor.

7. Connect the aircraft ground wire to the ship's metal structure and the fueling nozzle ground wire to the aircraft. Connect the fuel nozzle to the aircraft and start the fueling operation.

8. At the end of a fueling operation turn the switch near the hose nozzle to the OFF position. This automatically changes the solenoid fueling-defueling valve to the defueling position and empties the hose.

The defueling of aircraft can be accomplished simultaneously with fueling operations in the same quadrant or can be accomplished as a separate operation.

When defueling is carried on, jet fuel must be routed back to the JP-5 stowage tanks.

CAUTION: Aircraft suspected of containing low-flash fuels such as AvGas or JP-4 must never be defueled back into the JP-5 stowage system.

When defueling an aircraft while fueling operations are in progress in the same quadrant or as a separate operation, the following procedure must be observed:

1. Ground the aircraft to deck metal and ground the fueling nozzle to the aircraft. Connect the fueling nozzle to the aircraft.

2. Line up the defueling main so that JP-5 can be defueled to a slack JP-5 stowage tank that has been chosen to receive this JP-5.

3. After defueling is complete, close the hose nozzle, and remove from the aircraft.

4. When the hose is emptied, secure the defueling station pump and remove the electrical ground connections.

The general procedures for JP-5 system operation, applicable to all carriers, are as follows:

1. All valves in the JP-5 system, except gage cutout valves, should be closed when no operation is in progress.

2. Care should be exercised to prevent opening of JP-5 filling and transfer manifold valves leading to tanks that are ballasted.

3. The stowage tanks should be stripped immediately before transfer of JP-5 to the service tanks.

4. After fueling or defueling aircraft, the hoses should be drained. Draining of the balance of the system is not required. The system must be maintained 100-percent full of JP-5 at all times except for extended in-port periods.

5. The JP-5 service pumps should be started with the discharge valves closed, to avoid a pressure surge in the system. Then crack valves to allow pressure to build up slowly.

6. Do not deliver more than the rated capacity through the filters to avoid damage to the elements.

7. If the temperature at any JP-5 pump discharge exceeds 100° F, the pump should be stopped immediately.

RECEIVING JP-5 FUEL

The JP-5 stowage tanks are normally filled at one or both of the two starboard amidship filling connections when receiving fuel from a tanker. Filling connections are also located on the port side and may be used to receive fuel from a barge.

Each JP-5 filling station on the main deck is provided with a 6-inch, 90-degree portable ell, cutout valve, quick-release hose couplings, and the necessary hose handling gear for receiving JP-5 at sea. Each ell has the following fittings:

1-inch thermometer connection.
¼-inch test cock.
¾-inch low-pressure air connection (with plug).
¼-inch gage connection (with plug).

The procedures for receiving JP-5 for each carrier may differ somewhat, due to the system layout, tank locations, etc. The procedures presented here are therefore general in nature.

The system filling procedures are as follows:

1. Strip the stowage tanks to be filled before the filling operations are to start. Those tanks that are ballasted should be deballasted, using the ship's main drain and eductor system and any water remaining removed by the stripping pumps.
2. Line up the valves in the filling and transfer system from the main deck filling connection to the manifolds for the tanks to be filled.
3. When filling commences, open the manifold valves in the order that will assure the maximum filling rate.

Precautions to be observed when filling stowage tanks or transferring fuel:

1. Do not fill service tanks from the tanker.
2. Strip JP-5 tanks before receipt of JP-5 on board.
3. Strip the day after receipt.
4. Strip weekly thereafter as applicable.
5. If time allows, strip the day after transfer.
6. Strip just before transfer.
7. Order tanker to stop pumping when JP-5 stowage tanks are 100-percent full and overflow tanks are 95-percent full.

When filling less than six tanks simultaneously, which are served by the same overflow tank, keep a close watch of the level of the overflow tank and do not allow it to get ahead of the other tanks being filled. This must be done in order not to exceed the design overflow rate. In general, the tanks nearest to the downcomers will fill up first. When any tank is about 80-percent full, by a check from the tank level indicating system, start topping off the tank by slowly closing the manifold valve. Each tank should be filled to at least 95-percent capacity and the overflow tank filled last. Care must be exercised when tanks are almost full; the tanks should be topped off by throttling the "tank side" valve, in order to prevent overloading the overflow piping.

SAFETY PRECAUTIONS

Although JP-5 jet fuel has a relatively low vapor pressure, a relatively high flashpoint, and does not vaporize as readily as gasoline, it is important to remember that it will burn; therefore, it must be handled with great caution. The precautions to be observed in the handling of aviation gasoline are equally well applicable to the handling of JP-5.

The safety precautions for JP-5 fueling stations are as follows:

1. Only jet aircraft using JP-5 may be fueled and defueled by JP-5 stations. When defueling jet aircraft, the JP-5 must be directed to the JP-5 stowage tanks.
2. The fueling and defueling of aircraft is handled by the aviation JP-5 crew under the direction of the officer who is responsible for this procedure. No one but a member of the aviation JP-5 crew is to have anything to do with the fueling and defueling procedure.
3. Before beginning any fueling or defueling operations, the engine of the aircraft must be stopped, all engine switches must be turned to the OFF position, and all electronic gear turned off.

4. While the aircraft is being fueled or defueled, one of the aviation JP-5 crew with a portable carbon dioxide hand fire extinguisher must be stationed nearby.

5. Before fueling starts, a member of the aviation JP-5 crew with a mop must be stationed near each aircraft filling connection so that any spilled JP-5 can be immediately mopped up or spread to evaporate quickly.

6. A nonsparking pail, full of water, should be readily available for rinsing the mop. After rinsing thoroughly, air the mop in an exposed location. DO NOT BRING A CONTAMINATED MOP INTO AN ENCLOSED SPACE. Dump water used for rinsing the mop overboard to leeward, taking care to keep clear of any openings in the ship's structure.

7. Before attaching the hose nozzle to an aircraft tank filling connection, ground wires must be connected from the aircraft to the deck metal and from the hose to the aircraft to avoid static sparks. After the fueling operation has been completed, disconnect the nozzle from the tank filler connection and detach the nozzle ground before the aircraft ground wires are removed from the deck connection. Make sure the fuel tank filler cap is secured.

8. Leaks in tanks, lines, or connections, or trouble with handling equipment should be reported immediately to the officer in charge.

9. Stop JP-5 station defueling pump when the fuel at the discharge reaches a temperature of 100° F.

10. Stop fueling immediately when the pressure downstream of the pressure regulator reaches 60 psi.

RECORDS AND REPORTS

The division officer is required to maintain an accurate and up-to-date record of the contents of each tank used for the stowage of aviation fuel. The information for compiling this record is obtained from reports from the pumproom crews. This report, which is made out daily, lists the tanks by number. The nature and the quantity of the contents (e.g., JP-5, ballasted, deballasted) of the tank should be listed by each number. Once weekly each tank should be sounded with a sounding tape through the sounding tube and the reading of the tape compared to the liquid level gage reading. At the same time a sounding should be made using water detecting paste and/or a thief sampler for a check on the amount of water in the tank. This should be done whether or not fuel has been pumped from the tank. When the sounding has been made, corrections should be made to the record as indicated by the sounding.

Maintenance logs and work logs are kept by each JP-5 pumproom in the same manner as they are for the AvGas pumprooms. See chapter 5 of this training manual for details of these logs.

Chapter 7

PROTECTIVE SYSTEMS

The nitrogen gas and carbon dioxide (CO_2) systems are used for the protection of the aviation fueling system aboard ship by preventing or extinguishing fires. Both of these gases are nonconductors of electricity; therefore, they are safe to use near electrical equipment.

NOTE: Since the inert gas system is being replaced by nitrogen gas on most ships, it is not included in this training manual.

NITROGEN SYSTEM

Nitrogen gas is manufactured aboard ship by two or three oxygen-nitrogen producers, depending on the class of ship. The engineering department is charged with the operation and maintenance of the producers. The air department fuels division is responsible for the distribution of the nitrogen gas used in connection with the aviation fueling system.

ABF3s and ABF2s, as aviation fuel pumproom and filter room operators, are responsible for the operation of these systems. A thorough knowledge of the systems is of great importance in order that maximum utilization of their protective features be realized.

NOTE: There are variations of the nitrogen system from ship to ship. The system described in this chapter is typical of most ships.

Nitrogen, obtained in the fractional distillation of liquid air, is colorless, odorless, and tasteless, with a minimum purity of 97 percent, and is stored in flasks at 3,000 psi for use as required.

Nitrogen is used in the cofferdams as a protection against fire and explosion, in the double-walled piping to indicate the condition of piping, and in the distribution piping for drainback, purge, and charge.

Nitrogen is also used for charging flasks for aircraft, for missile checkout, and for aircraft tire inflation.

At the reducing panel (fig. 7-1), nitrogen pressure from the flasks is first reduced from 3,000 psi to 300 psi to facilitate subsequent reduction. It is then reduced and routed as follows: 300 psi to 4 psi for the cofferdams, 300 psi to 10 psi for the double-walled piping and 300 psi to 15 psi for the distribution piping. Each reducing valve is provided with a bypass line containing a globe needle valve. This bypass line must be used when charging the system with CO_2, or when bypassing an inoperative reducing valve.

NOTE: CO_2 cylinders used for the purpose of inerting shall not have internal siphon tubes installed, but shall be fitted with handwheel operated valves.

Nitrogen for charging the cofferdam is reduced to 4 psi at the pressure reducing panel. Low-pressure piping leads directly from the panel through the AvGas pumproom to the cofferdam. (See fig. 7-2.) A stop valve in the pumproom controls the release of nitrogen into the cofferdam. Diffusers at the ends of the supply lines serve to spread the gas throughout the space.

Escape piping for the cofferdam leads directly to the outside of the ship. A shutoff valve in this piping is located in the AvGas

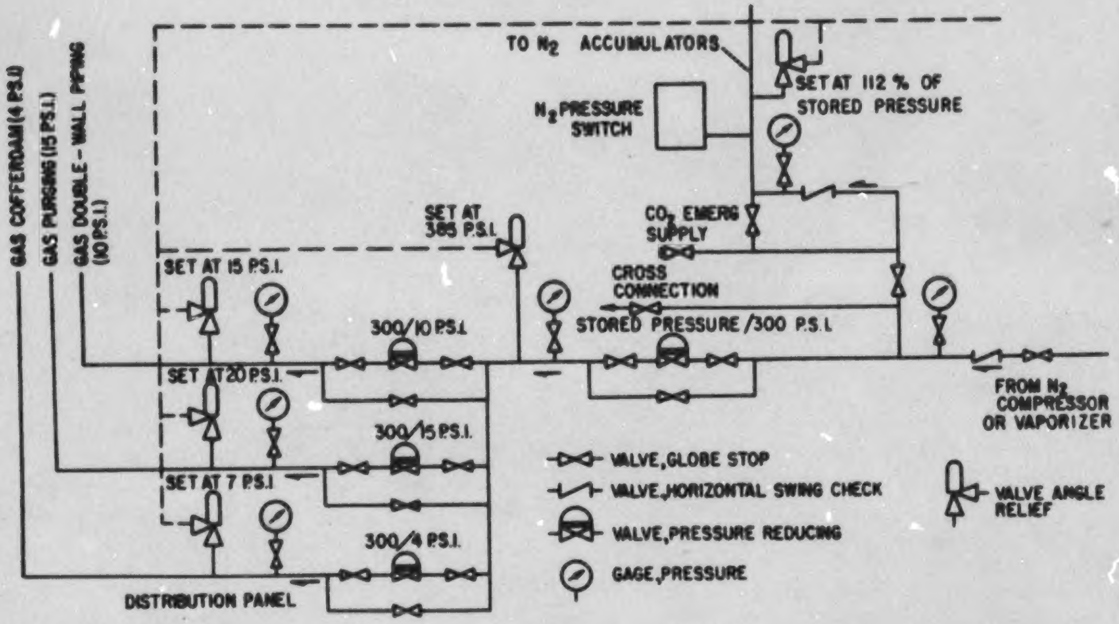
TO N_2 ACCUMULATORS
SET AT 112 % OF STORED PRESSURE
N_2 PRESSURE SWITCH
GAS COFFERDAM (4 P.S.I.)
GAS PURGING (15 P.S.I.)
GAS DOUBLE-WALL PIPING (10 P.S.I.)
SET AT 385 P.S.I.
CO_2 EMERG SUPPLY
SET AT 15 P.S.I.
CROSS CONNECTION
300/10 P.S.I.
STORED PRESSURE /300 P.S.I.
SET AT 20 P.S.I.
FROM N_2 COMPRESSOR OR VAPORIZER
300/15 P.S.I.
SET AT 7 P.S.I
VALVE, GLOBE STOP
VALVE, HORIZONTAL SWING CHECK
VALVE, PRESSURE REDUCING
GAGE, PRESSURE
VALVE ANGLE RELIEF
300/4 P.S.I.
DISTRIBUTION PANEL

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Figure 7-1.—Nitrogen pressure reducing panel.

pumproom. A relief valve set at 4 psi is installed in a bypass line around the shutoff valve to ensure against excessive pressure in the cofferdam. An additional relief valve, installed on a cross connection between the nitrogen supply line and the escape piping, also ensures against excessive pressure. Pressure gage and inertness analyzer connections are provided in the air escape piping.

The charging of the cofferdam surrounding the AvGas stowage tanks with nitrogen is generally accomplished by the AvGas pumproom operator.

The procedure for the operation is as follows:

1. Connect the portable inertness analyzer to the inertness analyzer connection.
2. Open the valve in the air escape line from the cofferdam.
3. Open the nitrogen supply valve in the AvGas pumproom.
4. As the nitrogen gas is flowing into the cofferdam, take inertness readings of the gaseous

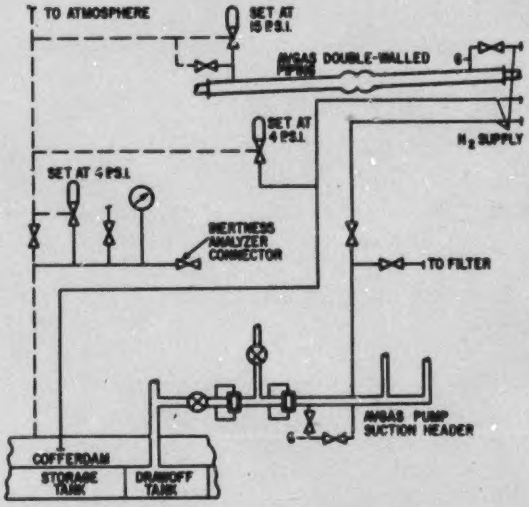
TO ATMOSPHERE
SET AT 15 P.S.I.
AVGAS DOUBLE-WALLED PIPING
G
SET AT 4 P.S.I.
N_2 SUPPLY
SET AT 4 P.S.I.
INERTNESS ANALYZER CONNECTOR
TO FILTER
AVGAS PUMP SUCTION HEADER
G
COFFERDAM
STORAGE TANK
DRAWOFF TANK

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Figure 7-2.—Nitrogen piping for the AvGas system.

mixture of air and nitrogen being discharged through the air escape line, using the inertness analyzer.

5. When the inertness reading reaches 50 percent, close the valve in the air escape line and the analyzer connection.

6. Allow the pressure in the cofferdam to build up to 1/2 psi; then close the nitrogen supply line valve.

The inertness readings must be taken on the cofferdam daily and entered in the AvGas pumproom log. The pressure should be noted at frequent intervals by the pumproom operator during operations and by the fuels security watch during nonoperating periods.

NOTE: If carbon dioxide is being used for inerting, an inertness of 35 percent should be obtained on the portable inertness analyzer before closing the valve in the air escape.

The double-walled piping is supplied with nitrogen from the reducing panel through a charging valve located in the third deck access trunk. Ensure that the casing vent valve is closed prior to opening the charging valve. The double-walled piping pressure gages are located on the main gage panel in the AvGas pumproom. Slowly open the charging valve; when the gage pressure reaches 10 psi, close the charging valve. A relief valve set at 15 psi is installed at the outboard end of the double-walled piping and is vented to the atmosphere.

If the pressure in the double-walled piping drops below 5 psi or rises above 10 psi, isolate the double-walled piping until the cause of the pressure change is detected.

Nitrogen for drainback is injected in the distribution piping through the filter discharge and filter bypass line. It is routed from the reducing panel to a supply valve in the AvGas pumproom, and from the pumproom through two stop valves–one to the port, and one to the starboard filter.

To drain back a quadrant, open the nitrogen supply valve in the AvGas pumproom and filter room. Open the nitrogen drainback lines to the filter discharge and filter bypass lines. When the suction header reflex sight level gage indicates that the piping is empty, isolate the AvGas stowage tanks. This operation should be done carefully to prevent nitrogen from entering the gasoline stowage tanks. Secure the nitrogen supply valve to the filter and purge.

To purge a quadrant, open the nitrogen supply valve to the AvGas pump suction header. Start with the farthest service station from the pumproom and place it in the fueling position. Connect the portable inertness analyzer to the air and vapor eliminator exhaust line. When the inertness reading reaches 50 percent, secure the station and charge the piping to 9.5 psi. Secure the nitrogen supply valve to the suction header.

NOTE: AvGas quadrants are drained back and purged daily after operations.

Whenever using carbon dioxide, purge the system to a minimum of 35 percent inertness.

MAINTENANCE

Maintenance of the nitrogen distribution system for the AvGas system (except for the distribution panel) is the responsibility of the fuels division. The ABFs assigned as pumproom and filter room operators as well as those assigned as repairmen for the AvGas system generally perform this maintenance. Maintenance of the system consists essentially of periodic checks for leakage, replacement of faulty valves, and routine upkeep in accordance with current 3-M procedures.

CARBON DIOXIDE SYSTEM

Fixed carbon dioxide (CO_2) systems are provided for the protection of the AvGas pumproom, motor room, access trunk, and filter room. In addition to the two fixed systems, portable 15-pound CO_2 extinguishers are provided at strategic points in the aviation fueling system for extinguishing fires.

The fixed CO_2 system for the AvGas pumproom, motor room, and access trunk consists of the required number of 50-pound CO_2 cylinders located in the motor room. Each system is fitted with two pressure-operated switches whose functions are explained later. These cylinders are connected to piping which leads to the above spaces. The cylinder release valves are operated by a cable connected to pull boxes located remote from the space. You should learn the exact location of these pull boxes on your ship.

The CO_2 system for the AvGas and JP-5 filter room consists of the required number of 50-pound cylinders located in a space outside of the filter room. The cylinders are connected by piping to the filter room, and the cylinder release valves are operated by cables connected to pull boxes located remote from the space. Learn the exact locations of these pull boxes on your ship.

The emergency pull box is made watertight by a metal cover equipped with a rubber gasket which is held in place by friction clutches on the rim. A labeled glass plate located under the cover contains instructions for operating the pull box. The handle is connected through a cable pulley arrangement to a type I, class C cylinder valve on the head of the CO_2 cylinder.

The pull box is operated by opening the metal cover, breaking the glass cover, and pulling out the handle until the red portion of the cable shows.

NOTE: Incorporated in the system is a time delay switch which allows between 20 to 30 seconds before CO_2 is discharged. This is to allow time for personnel to vacate the space.

Released CO_2 gas flows through the piping to the AvGas pumproom, motor room, and the access trunk, or to the AvGas filter room. Diffuser horns located on the ends of the CO_2 piping spread the gas to form a smothering blanket, eventually filling the space in which it is released. CAUTION: Since CO_2 is suffocating, every effort should be made to remove all members of the pumproom crew prior to discharging the gas.

Two pressure-operated switches are connected to the CO_2 distributing piping of each of the fixed CO_2 systems. In each case, one of the switches is interlocked electrically with the controller for the ventilation fan serving the space. The other pressure-operated switch operates visible and audible alarms.

The visible alarm is mounted at the access to the space. Thus, when CO_2 is released into the space, the ventilation fan for the space is stopped and the visible alarm is automatically turned on to warn all personnel to stay clear until ventilation has been restored and proper tests have been accomplished to assure that the space is safe to enter.

Visible and audible alarms are provided for each system on the hangar deck. These alarms consist of a bell, a green or white light labeled VENTILATION ON, a red light labeled VENTILATION OFF, and an electrical switch. The alarms operate automatically at any time the ventilation is interrupted, either by the release of CO_2 into the space or by electrical failure of the exhaust ventilation blower for the ventilation system.

When the ventilation for the spaces is operating normally, the green light glows, indicating that the ventilation exhaust blowers are on. In the event of stoppage of a blower, the alarms for that space are actuated. The bell commences to ring, the green light goes out, and the red light becomes lighted. The bell may be turned off prior to restoration of ventilation to the space by turning the electrical switch at the alarm station to the OFF position. The red light will continue to glow until ventilation is restored, at which time it will go out and the green light will become lighted. The switch at the alarm station must be returned to the ON position after restoration of ventilation in order for the audible alarm to actuate during subsequent stoppages of the ventilation system.

Maintenance of the fixed CO_2 systems, other than routine cleaning and painting, is accomplished by the damage control group of the ship's engineering department. Routine cleaning and painting of the system is the responsibility of the men assigned the cleaning stations in which the systems are located.

NOTE: The 50-pound CO_2 bottles are weighed and recorded prior to installation and at least every 6 months thereafter. The 15-pound portable bottles are weighed monthly.

Chapter 8

AVIATION LUBE OIL SYSTEMS

Since jet aircraft are rapidly replacing piston engine aircraft, the usefulness of the aviation lube oil system on certain ships has diminished somewhat.

A ShipAlt issued to some carriers requires the lube oil system to be modified from the main deck up by removing all service distribution piping, ready service tanks, and associated hardware.

A 55-gallon tank or similar container fitted with a hand pump and strainer, and mounted on a surplus bomb cart, is filled from the lube oil outlet in hangar bay one to replenish the steam catapult's reservoirs. This ShipAlt applies only to certain ships. Lube oil systems on other ships remain the same.

The aviation lube oil system (also known as piston engine lubricating oil system) on board aircraft carriers is maintained by the aviation fuels division (V-4).

Although lube oil systems will vary in some respect from ship to ship, a man qualified in one system can easily and quickly qualify in the operation and maintenance of other lube oil systems. These systems are intended for the stowage and distribution of reciprocating engine oils.

All naval aircraft reciprocating engines use a single grade of dispersant type oil, Specification MIL-L-22851, TYPE II, NATO 0-128. This is a grade 1100 base oil with additives to improve oxidation resistance, to hold in suspension sludge and varnish-forming particles, and to reduce foaming tendencies. Standard oil dilution procedures are used with this oil for cold weather operations.

Oil for jet engines is provided in sealed cans and is handled through the supply department.

LUBE OIL SYSTEM

The aviation lube oil system is a separate, independent system composed of pumps, valves, and piping arranged to supply a ready service tank located on the gallery deck. The main pumps take suction from the manifolds connected to the built-in tanks and discharge through a manifold to the riser supplying the service tank.

The ready service tank is provided with a hand-operated pump for supplying the flight deck station. The ready service tank supplies one station on the hangar deck by gravity flow.

Each service station outlet is provided with a hose valve and short length of oil hose with nozzles for filling the 5-gallon oil cans. A drip pan is provided at each station.

Filling connections of the flush deck type are provided on the hangar deck, port and starboard, suitable for attaching funnels of the type used when filling from drums. These filling connections are of sufficient size to provide a free flow when five drums are discharging at the same time.

A transfer cross connection is provided to enable piston engine lube oil to be supplied directly to the steam catapult's service tank from the lube oil system, thereby eliminating the need for hand filling of the catapult service tanks.

The stowage tanks are provided with steam heating coils, overflows, sampling connections, distant reading thermometers, tank level indicating system consisting of balanced mercury gages, and try-cocks (spaced 6 inches apart) for determining the oil level in the various tanks.

OPERATION

The piping is arranged in the pumproom so that the following operating conditions may be obtained:

1. That either or both pumps may simultaneously take suction from any stowage tank and discharge to the ready service tank or to any other stowage tank.

2. That either pump may take suction from any stowage tank and discharge to the ready service tank while the other pump is taking suction from the same (or any other) stowage tank and discharging to any other stowage tank.

3. That either or both pumps may take suction from or may discharge to the filling line.

4. That either or both pumps may take suction from the ready service tank to assist in draining the system.

5. That the return mains and risers may be utilized as supply mains and risers in the event of damage, by operation of the valves in the pumproom.

Figure 8-1 is a schematic of the lube oil system.

Loading Oil

To fill the stowage tank, rig the filling connection on the main deck and open valve L. (See fig. 8-1.) Open valves H and J, A and B of desired pump suction and discharge, and valve C to the tank. Start the lube oil pump and observe conditions of filling by means of the tank level gage in No. 1 auxiliary machinery room.

The stowage tank may be filled by either of the following methods:

1. POURING FROM DRUMS. Screw a large funnel into the filling connection, raise the drum above the filling connection using a forklift or by other means, and open the large cap. The large cap should be on the bottom near and over the funnel. Next, open the small cap on top to allow air into the drum. The amount of oil leaving the drum can be controlled by opening and closing the top cap.

2. SIPHONING FROM DRUMS. A 1 1/4 inch gasoline nozzle may be rigged with a brass nozzle long enough to reach to the bottom of the drum, and a hose from the nozzle rigged with a fitting into the filling connection. Using this method, the vacuum from the lube oil pumps may be utilized for loading.

3. LOADING FROM A TRUCK ON THE DOCK. Rig a direct line from the truck to the filling connection. When this method is used, a pump on the truck is utilized to boost the oil from the truck to the filling connection.

CAUTION: When using method 3, use caution to ensure that the pressure from the truck to the lube oil system is not enough to cause damage to hose, piping, and pumps.

When taking on lube oil, a vent is not necessary as the system is vented through the tank to the overflow tank. The valves from the tank to the overflow tank are locked open during this operation. Tanks should not be filled beyond 95 percent capacity, to allow for expansion.

Pumping to Ready Service Tank

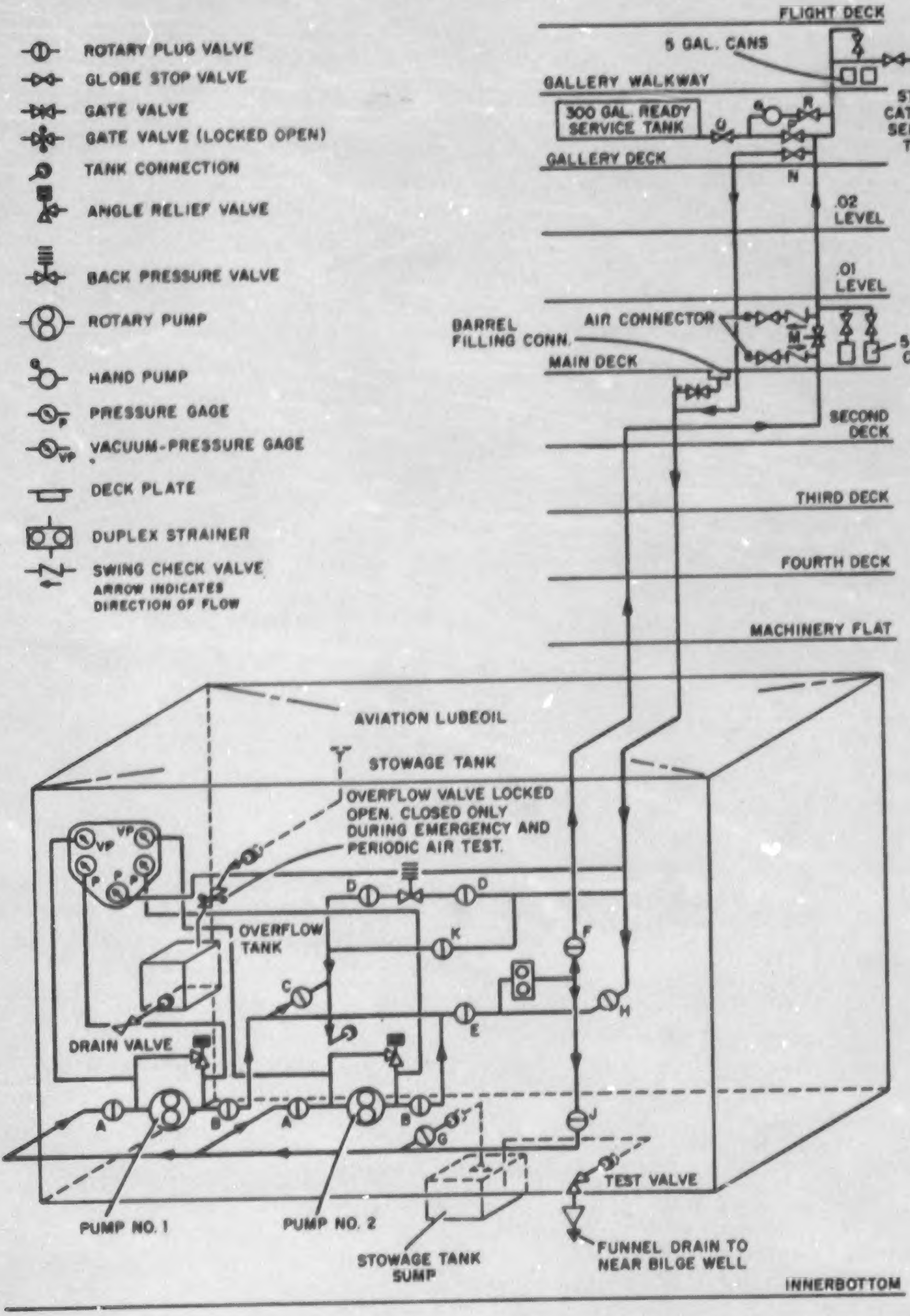
To draw oil from the stowage tank and discharge to the ready service tank on the gallery deck, use the following procedures:

Oil in the tank should first be heated to a temperature of approximately 100° F. Open valve G from the tank and valves A and B of the desired pump suction and discharge. (See fig. 8-1.)

NOTE: Some ships have only one pump installed in the piston engine lube oil system.

Open valves E and F at the strainer inlet and outlet. Open the rotary plug valves on each side of the back pressure valve. Start the pump and observe conditions of operation from the tank level gage, pump suction and discharge. Open valves P and Q. Observe conditions of filling by the tank level gage on the ready service tank.

Check and clean all strainers in the system periodically.


ROTARY PLUG VALVE
GLOBE STOP VALVE
GATE VALVE
GATE VALVE (LOCKED OPEN)
TANK CONNECTION
ANGLE RELIEF VALVE
BACK PRESSURE VALVE
ROTARY PUMP
HAND PUMP
PRESSURE GAGE
VACUUM-PRESSURE GAGE
DECK PLATE
DUPLEX STRAINER
SWING CHECK VALVE
ARROW INDICATES DIRECTION OF FLOW
FLIGHT DECK
5 GAL. CANS
GALLERY WALKWAY
STEAM CATAPULT SERVICE TANK
300 GAL. READY SERVICE TANK
GALLERY DECK
N
.02 LEVEL
.01 LEVEL
AIR CONNECTOR
BARREL FILLING CONN.
MAIN DECK
5 GAL. CANS
SECOND DECK
THIRD DECK
FOURTH DECK
MACHINERY FLAT
AVIATION LUBEOIL
STOWAGE TANK
OVERFLOW VALVE LOCKED OPEN. CLOSED ONLY DURING EMERGENCY AND PERIODIC AIR TEST.
OVERFLOW TANK
D
D
K
C
F
E
H
DRAIN VALVE
A
B
A
B
G
J
TEST VALVE
PUMP NO. 1
PUMP NO. 2
STOWAGE TANK SUMP
FUNNEL DRAIN TO NEAR BILGE WELL
INNERBOTTOM

197.58

Figure 8-1.—Schematic of lube oil system.

Servicing From Ready Service Tank

To serve outlets from the ready service tank with motor pumps inoperative, use the following procedures:

1. Main deck service stations. Close valve M (main deck riser) and valve N on the gallery deck. Open valves P and Q.

2. Gallery walkway service station. Close valves M and N. Open valves Q and R. Operate the hand pump located at the ready service tank.

Draining Back the System

To blow out the loop to the service tank, close valve M in the main deck riser. Open valves F, H, and K. Alternately open air valves above and below valve M.

Securing the System

The lube oil system is secured after each operation. This is accomplished by securing all valves except M and N, the loop supply cutout valves on the main and gallery decks, the stowage tank overflow valve located in auxiliary machinery room No. 1, and the used aviation oil drain valves on the fourth deck. Prior to securing the system, ensure that the ready service tank is filled.

NOTE: Complete operating instructions are contained on a board mounted in the lube oil pumproon.

CONTAMINATED LUBE OIL STOWAGE TANKS

There are three types of contaminated lube oil tanks in use on aircraft carriers.

Some contaminated lube oil drains are connected to the ship's contaminated oil stowage tanks which are maintained by the engineering department for stripping NSFO stowage and service tanks.

CAUTION: Aviation lube oil contaminated with AvGas should NEVER be put into these tanks due to the fire hazard that it presents. This type tank has no means of protection.

There are two types of protected lube oil tanks–the first is protected by displacing the air in the tank with an inert gas. This tank is usually maintained by the aviation fuels division and controlled and operated through piping and valves located in the aviation lube oil pumproom.

The second protected tank makes use of sea water to provide protection. This contaminated oil tank is initially filled with sea water from the ship's fire main. As contaminated oil is poured into the contaminated oil drain openings, it displaces the sea water overboard through an overboard discharge line. When the tank is to be emptied, sea water from the ships fire main is introduced into the tank to force the oil overboard through the overboard discharge line.

This tank may be maintained either by the aviation fuels division or the engineering department.

CONTAMINATION

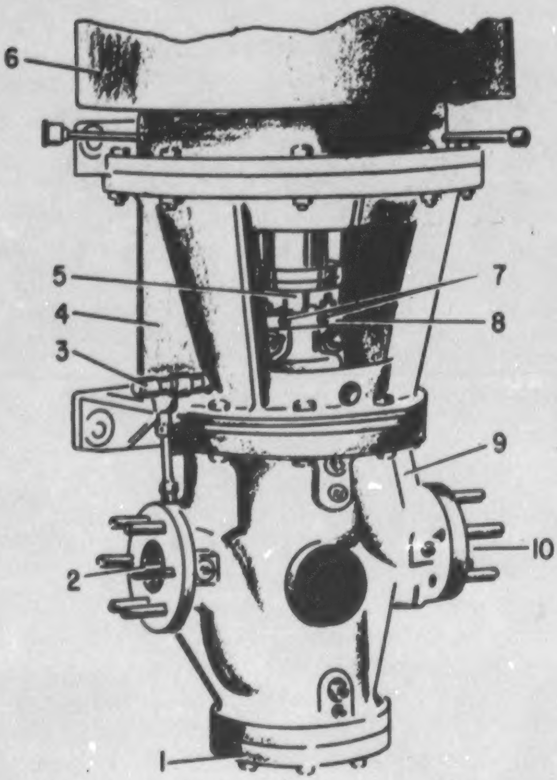
Contamination is always a problem in aviation lube oil and should be a matter of great concern to the ABF. The sources to check for contaminants are the ready service outlets, ready service tanks, and the stowage tanks.

The ready service outlets should be checked each time that oil is dispensed from them by first taking a small sample from the outlet and inspecting it for rust, water, and any other contaminants. If contaminants are found, the strainer to the outlet should be pulled and checked. The ready service tanks should be checked periodically, drained, and cleaned. Also, the stowage tanks should be checked before each yard availability; and if rust or other contaminants are present, it should be planned to drain and clean them during the yard period. If contamination is found at any time, the source must be checked and eliminated before oil is issued to aircraft.

LUBE OIL PUMP

The De Laval-IMO series 31P156 pump used in aviation lube oil systems is of the vertical, single stage, positive displacement, rotary, screw type. The pump consists essentially of a power rotor that moves the oil, two idler rotors for sealing purposes, and the housing, thrust elements, shaft packing, and piping connections. Figure 8-2 shows the lube oil pump.

Oil enters the pump through the centrally located suction opening (2, fig. 8-2) and flows through the passage in the case to the lower end where it is entrained by the helical grooves of the rotating power rotor. The two idler rotors have helical grooves which mesh closely with the grooves in the power rotor. As the power rotor turns, these grooves move the oil along the axis of the power rotor to the upper or high-pressure end of the power rotor. At this point, the fluid is forced into the discharge line (10) in a steady continuous flow.



1. Lower end cover.
2. Suction connection.
3. Relief valve.
4. Shaft housing.
5. Shaft.
6. Power unit.
7. Adjusting screws.
8. Packing gland.
9. Pump case.
10. Discharge connection.

Figure 8-2.—Lube oil pump. 197.59

The idler rotors are driven by the power rotor with which they mesh. All three rotors are enclosed in a close-fitting housing, and the intermeshing threadlike forms of the rotor are so shaped and proportioned that leakage from the discharge passage to the suction passage is a negligible factor at all operating pressures. The power rotor carries practically the entire pumping load, while the idler rotors act as seals and provide some assistance in moving the oil. The unbalanced axial thrust of the power rotor is absorbed by thrust washers.

POWER ROTOR

The power rotor is a single forged steel piece which has a section of helical grooves along the central portion and a shaft extending from each end. The helical grooves extending the length of the central portion give the rotor the appearance of a large screw. These grooves are specially cut to mesh with the idler rotors. A balanced piston, which is an integral part of the rotor, is designed to aid in counteracting axial thrust by forcing oil against the effective area on its underside.

IDLER ROTORS

Each idler rotor is a steel forging with helical grooves and an integral shaft and thrust collar at the lower end. The helical grooves are narrower than those on the power rotor and are carefully cut to mesh closely with the power rotor. The thrust collar or flange at the lower end is designed to absorb axial thrust.

ROTOR GUIDES AND LOCATING ELEMENTS

The rotors are positioned radially by the housing, by each other, and by the rotor bearing block. The power rotor is also positioned radially by the balance piston housing. The power rotor is positioned axially at the lower end by a stop collar which bears against a thrust washer in the rotor bearing block on downward thrust, and at the upper end by the integral balance piston which bears against the thrust washer on upward thrust. Normally, the two components of this upward thrust element are not in contact. The idler rotors are positioned axially by the integral thrust collar which bears against the rotor bearing block at the lower end of the pump. The oil being pumped lubricates all bearing surfaces.

HOUSING

The rotor housing (located within the pump case) closely encloses the helically grooved section of the rotors. The housing has an integral flange on the upper end which butts against a shoulder in the pump case (9, fig. 8-2) when the housing is installed. The housing is secured axially in the pump case by adjusting screws (7) in the upper end. These adjusting screws also position the balance piston housing and the packing box end cover in their proper places. The housing has three overlapping bores which keep the rotors properly meshed and retain the oil in the helical grooves. The housing is prevented from rotating by a housing stop pin which secures it to the pump case.

HYDRAULIC BALANCE

Hydraulic unbalance has been effectively eliminated from the power rotor by means of the balance piston on the upper end of the rotor. The required upward hydraulic force comes from the high-pressure oil acting on the effective area on the underside of the balance piston.

SHAFT PACKING

There is only one stuffing box in the pump, and it is located in the packing box end cover. Four flexible metallic packing rings, installed with the joints of abutting rings staggered, and a packing gland (8) prevent oil from leaking out along the shaft (5) where it passes through the packing box end cover. The glands consist of two parts to allow servicing the packing without disturbing the other elements of the pump. The two parts of the gland are held together by two screws, and the gland pressure is adjusted with the two gland nuts on the gland bolts.

CASE

The pump case (9) is a steel casting which encloses all internal parts of the pump. Flanged suction and discharge connections are integral parts of the pump case, as is a flange which provides a means for mounting the pump. The upper end of the case is closed with the packing box end cover and the lower end with the end cover. The case also has a relief valve (3) which relieves any excessive oil pressure building up under the thrust washer by discharging oil to the suction side of the pump. The relief valve also seals the metallic packing against air leakage during suction lift conditions. The valve should be set to maintain 15-psi pressure on the packing box.

OPERATING INSTRUCTIONS

When the pump is started for the first time or after a long period of idleness, follow the instructions for initial starting given below.

Initial Starting

All external surfaces of the pump should be carefully cleaned before the pump is started. If the factory assembly has not been disturbed, it will not be necessary to dismantle the unit for cleaning. The interior was slushed with a special rust preventive compound after the factory test. The removal of this compound is effected completely without any harmful results in the normal operation of the unit.

Ensure that the shaft packing has been installed and that the gland nuts are only finger-tight.

Before starting the pump, prime it by filling the pump case and as much of the suction line as possible with oil. If the air is not removed from the suction line, the performance of the unit will be erratic, or it will not pump at all. If no priming connection is provided, it will be necessary to remove the plug on the suction connection of the pump and fill with oil.

Open the suction, discharge, and vent valves and start the motor. Ensure that the motor rotates in the direction indicated on the pump case. If the pump is moving the oil satisfactorily, the vent valve may be closed after a few minutes of operation. Allow the shaft packing to leak freely for the first 15 minutes of operation, and then tighten the gland nuts with the fingers until there is only a slight leakage past the packing.

If the pump fails to discharge after starting, stop the motor, prime the pump again, and restart the pump. If it still does not pick up oil immediately, there may be a leak in the suction line, or the trouble may be traced to excessive suction from an obstruction, throttle valve, or other causes. Connecting a gage at several points along the suction line, while the pump is operating, will help locate trouble. An obstruction in the suction line will cause an observable drop in pressure at the point of obstruction, the lower pressure being on the pump side.

CAUTION: Running the pump without oil will cause rapid wear of the housing and bearings.

Routine Starting

Open the suction and discharge valves and start the motor. Ensure that oil is being pumped and that there is slight leakage past the shaft packing. Read the gages that indicate the suction and discharge pressures for the pump and be sure the pump is operating normally before leaving it unattended. If it is not pumping, follow the instructions for initial starting.

Running

After the pump is in service, it will continue to operate satisfactorily with little or no attention. The suction and discharge pressures should be checked at least every 10 minutes to verify the performance of the pump. Once each day the shaft packing should be inspected to see that it is properly adjusted. Any unusual conditions should be noted and investigated.

Securing

Stop the motor and close the suction and discharge valves.

MAINTENANCE

De Laval-IMO pumps require very little attention in normal usage. Unless they are run without oil. or are run with oil containing abrasive particles, they may be operated indefinitely without major overhaul.

Inspection

In addition to a daily check of the shaft packing as described above, the exterior of the pump casing should be carefully cleaned once a month. An inspection made while the pump is running will then disclose any leakage between the end covers and case, or in the piping connections. If leakage is observed, it may be due to foreign matter on the gaskets, defective gaskets, or loose nuts and bolts. Replace the gaskets or tighten the nuts and bolts as required.

Lubrication

The pump does not require any lubrication since the oil being pumped lubricates all the moving parts.

Driving unit lubrication instructions are provided in the driving unit instructions for each unit.

Operating Troubles

Some operating troubles may be evident from a low discharge pressure, excessive or unusual noise, or an overloaded driving unit. The following paragraphs discuss the most likely causes of operation troubles.

LOW DISCHARGE PRESSURE.–A low discharge pressure generally indicates that not enough oil is being pumped. This condition may exist because the pump needs priming, or because of leakage. A gradual decrease in discharge pressure over a period of time is generally the result of pumping oil containing abrasive particles that cause wear of the housing and rotors.

NOISE.–Excessive or unusual noises may be caused by cold oil, dirty strainers, air in the oil, vaporization of the oil due to increased temperature, or misalignment of coupling.

OVERLOADED DRIVING UNIT.–Excessive friction in the pump or in the driving unit can cause a driving unit to be overloaded. Misalignment of parts when reassembling the pump will increase friction. Overloading may also be caused by faulty operation of the system, heavy or cold oil, or from other causes that are not due to any malfunctioning of the pump.

For detailed information of the De Laval-IMO lube oil pump see Instruction Book, Aviation Lube Oil Pump, NAVSHIPS 347-2329.

RECORDS AND REPORTS

OPERATIONAL

An operational logbook is maintained in the lube oil pumproom. This logbook should contain all operational data, such as which pump was operated, length of time pump was in operation, and where oil was discharged. This logbook should be inspected by the division chief every week and by the division officer every month.

MAINTENANCE

All work performed on the lube oil pumps, tanks, strainers, gages, and associated valves and piping should be recorded in a maintenance log in a day-to-day order. This log should also contain a record of lubrications, inspections, changes, etc.

The maintenance log should be inspected by the division chief once a week and by the division officer once a month.

All logbooks maintained in the lube oil system should be made in duplicate. The rough logs should remain in the lube oil pumproom and the smooth logs maintained in the aviation fuels division office.

CHAPTER 9

AVIATION FUELS REPAIR TEAM

The Aviation Fuels Repair Team is responsible for the equipment used for, and the repair and maintenance of, the aviation fuels system.

Repair team personnel must have a thorough knowledge of the aviation fuels stowage and distribution system, the operation of assigned damage control equipment, and applicable damage control procedures. They must also be familiar with the properties and hazards of aviation fuels and safety precautions.

The major duties of this repair team are as follows:

1. Locate and isolate damage to the aviation fuels stowage and distribution system.
2. Clear spaces of aviation fuels and fuel vapor by approved methods.
3. Make tests to determine the presence or absence of explosive vapors and oxygen.
4. Make emergency repairs to the aviation fuels system.
5. Operate and maintain equipment necessary for the above functions.

ORGANIZATION

GENERAL QUARTERS

During general quarters, the aviation fuels repair team becomes part of the ship's damage control organization.

The damage control organization is necessarily an integral part of the Engineering Department. An engineering officer, known as the DCA (damage control assistant), is charged with the overall coordination of all damage control matters.

The aviation fuels officer is in charge of the repair team, with a senior petty officer from the V-4 division as his assistant. The men who are normally assigned for maintenance in the division make up the repair team. Others assigned to this repair team include personnel in the HM, HT, and EM or IC ratings.

The number of men assigned to this repair team will depend upon the number of men available for all stations.

FLIGHT QUARTERS

During normal working hours and flight quarters, the aviation fuels repair team is only partially manned, unless otherwise directed by the air officer. This skeleton crew usually includes a petty officer in charge, a phone talker, and various repairmen. The petty officer in charge is usually an ABF2, and the repairmen are either ABF3s or ABF strikers. If other personnel are needed to handle casualties, flight deck and hangar deck fueling crews are used.

AVIATION FUELS SECURITY WATCH

This watch is stood at all times when the ship is not at general, fire, or flight quarters. Only qualified personnel from the V-4 division stand this watch, usually ABF3s and ABF strikers.

The aviation fuels security watch is responsible for the security of the aviation fuels systems. His duties include hourly inspections of all pumprooms, piping, and fueling stations. He is required to make hourly entries in the pumproom log and the repair team log and report to the air department integrity watch officer or OOD by phone.

The aviation fuels security watch must immediately notify the fuels officer, air department duty officer, and the integrity watch officer if leaks or other discrepancies are found in the aviation fuels system. If it is necessary, he must also request the OOD to put out the smoking lamp.

EQUIPMENT

The equipments for making repairs and tests of the aviation fuels systems are stored and maintained in the aviation fuels repair team shop. The major items of equipment consist of the combustible gas indicator, flame safety lamp, portable blowers (air turbine driven), dual service portable inertness analyzer, nonsparking tools, air line hose masks (except those provided in the AvGas pumprooms), and sound-powered telephones.

The sound-powered telephones are issued and accounted for by Repair team personnel. Maintenance of the phones is done by IC electricians in the Engineering Department.

COMBUSTIBLE GAS INDICATOR

The combustible gas indicator (explosimeter) is a portable electric instrument used to detect flammable and explosive mixtures in the atmosphere. This indicator is shown in figure 9-1.

The instrument is in a metal case which has a hinged cover. The case is divided into two parts. The lower section holds six No. 2 dry cell batteries which supply current to the electrical testing circuit. Located in the upper section are the indicator dial, the control switches, the electrical system, and the mechanism which brings the air in for sampling.

An aspirator bulb, suspended from one side of the case, is squeezed to draw air in through an inlet on the opposite side. A hose may be connected to the inlet fitting if an air sample is being taken from locations difficult to reach. Continued pumping of the bulb draws air through a combustion chamber where it is tested for explosive vapor content and then discharged to the atmosphere.

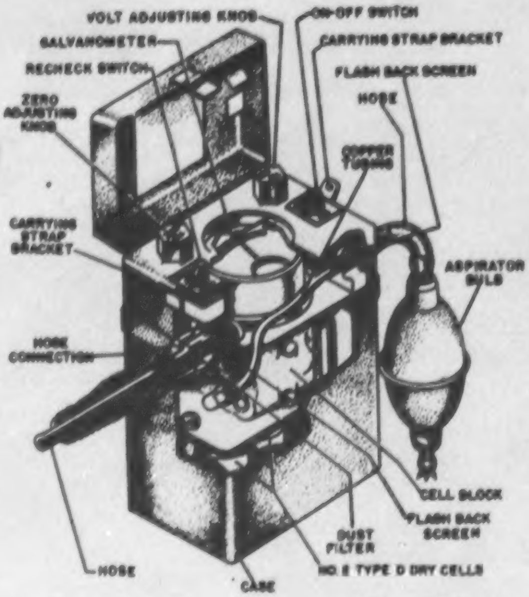


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Figure 9-1.—Combustible gas indicator.

The indicator dial is located on the top of the instrument under the hinged cover. The dial band is graduated in degrees of explosibility. This refers to the lowest concentration of gas or vapor that will burn. This point is indicated on the dial as 1.0 and is equal to 100 percent combustibility. Lesser concentrations are percentages of this figure. The dial band is also marked in three colors indicating safe, dangerous and explosive conditions as follows:

DEGREE	COLOR	INDICATION
Zero to 0.2	Green	Safe
0.2 to 1.0	Yellow	Dangerous
Over 1.0	Red	Explosive

Toggle switches are located on either side of the indicator dial. The right-hand switch is marked ON-OFF. This is a connecting switch between the battery supply and the testing circuit. When operating the instrument, turn this switch ON.

The left-hand switch is marked CHECK-READ. In the CHECK position, the dial indicates whether sufficient current is being supplied from the batteries. The pointer should rest on a green arrow in the center of the dial. If it does not, the electrical supply may be adjusted by turning the knob marked VOLT ADJ, which is located on the right-hand side of the indicator.

In the READ position, the dial pointer should fall to zero. This may be adjusted by turning the knob marked ZERO ADJ. This knob is located on the left-hand side of the dial.

To use the indicator properly, proceed as follows:

1. Throw the right-hand switch down to the ON position.
2. Throw the left-hand switch to the CHECK position.
3. Set the needle on the dial to the green arrow by turning the VOLT ADJ. knob.
4. Throw the left-hand switch down to the READ position. Aspirate the bulb for fresh air (press and release at least five times) and, by turning the ZERO ADJ. knob, bring the needle to zero.
5. If the space or compartment to be tested can be readily entered, walk through it while aspirating the bulb. Test the space at several levels. CAUTION: An operator should never enter a suspected area without wearing the proper breathing apparatus.
6. If the space is below a hatchway and is difficult to enter, attach the rubber suction hose. After lowering it into the space, move it around to find any pockets of vapor that may have accumulated.
7. After each use disconnect the suction hose and aspirate the bulb five or more times to purge the indicator. Purging is complete when the needle has returned to zero. The ON-OFF switch is shut off by closing the cover.

Each indicator is accompanied by a complete set of operating and maintenance instructions. In addition, a condensed operating routine is attached to the inside of the case cover. Maintenance of the indicator is usually accomplished by the damage control group or by naval shipyard personnel.

FLAME SAFETY LAMP

This indicator is used to determine the presence or absence of sufficient oxygen to support life. The flame safety lamp is used to test a space ONLY after the combustible gas indicator has given a negative indication of the presence of flammable gases.

As shown in figure 9-2, the lamp has a metal base which is the reservoir or font for fuel. The font is filled through an opening in the font top which is capped with a screw plug.

CAUTION: Only high grade nonleaded gasoline or naphtha should be used in this lamp.

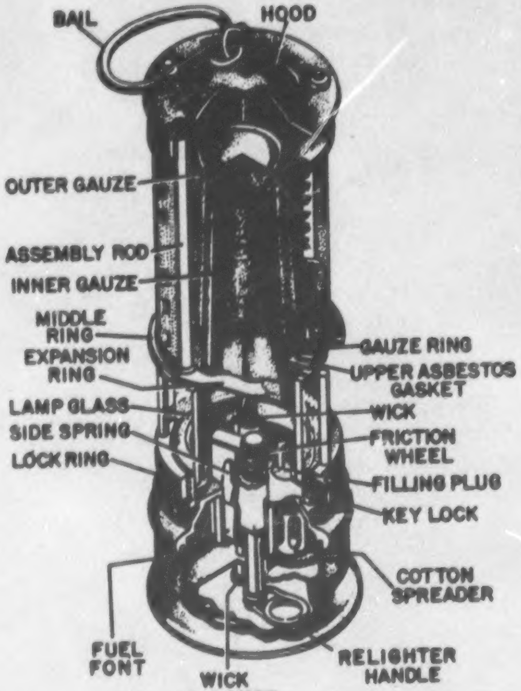

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Figure 9-2.—Flame safety lamp.

The flame end of the wick is held vertically by a tube in the lamp font. A wick adjuster raises and lowers the wick to adjust the size of the flame.

A friction wheel, operated by the relighter handle under the lamp, is used to strike a kindling spark off the spark pin.

A perforated metal bonnet is supported by posts above the lamp glass on the lockring. An expansion ring and asbestos gasket which are inside the lockring ensure an airtight joint between the base and the lamp glass. When the flame is lit, the heat in the lamp creates an updraft. This draws air from the outside through the lower gauze ring, past the flame, and into the interior of the lamp to the vent under the hood.

The air entering the lamp passes through the two metallic gauze cones. These cones, together with the bonnet, confine all burning to the inside of the lamp and prevent the ignition of vapors that may be present outside the lamp.

When preparing the lamp for use, the cotton wick is saturated with fuel. The fuel which is not absorbed by the cotton is allowed to drain out. All excess fuel must be carefully wiped away, since it will evaporate while the lamp is in use and cause a false reading.

CAUTION: The gauze cones, air admission ring, and glass shield must be clean and free from any damage; otherwise, the flame will not be completely confined in the lamp, and an explosion may result.

To light the lamp turn up the wick and actuate the relighter handle. Allow the flame to burn about 5 minutes prior to making tests to assure that the lamp is operating normally. CAUTION: Never light or relight the lamp in an explosive area.

Adjust the flame until its height is approximately three-eighths inch when burning in normal atmosphere. The lamp should be tested by blowing against the glass and gaskets. A leak will cause the flame to flicker.

When making tests, always hold the lamp in a vertical and upright position. The lamp must be lowered into or withdrawn from the space under test very slowly. Rapid movement of the lamp may cause the flame to be drawn through the wire gauze, thus igniting any gas that may be present.

The flame safety lamp is generally to be used only to show the presence or absence of sufficient oxygen to support life, but the presence or development of other dangerous conditions is indicated by the action of the flame, as follows:

1. If the flame goes out quickly, there is a deficiency of oxygen (less than 16 percent).
2. If the flame goes out with a slight "pop," it indicates the presence of a concentration of explosive gas.
3. If the flame flares up brightly, it indicates the presence of a lean concentration of explosive gas.
4. If the flame flares up and then goes out, it indicates the presence of a rich concentration of explosive gas.

In making tests, the lamp must be lowered to the bottom of the compartment, except in instances where the presence of gas or a deficiency of oxygen is indicated before the bottom is reached.

DUAL SERVICE PORTABLE INERTNESS ANALYZER

The dual service portable inertness analyzer is a battery-powered, electrical instrument used to measure the percent inertness (percent reduction of oxygen content) of an enclosure charged with inert gas. It may be used in connection with an inert gas mixture having an approximate composition of 86-percent nitrogen, 12-percent carbon dioxide, and 2-percent oxygen; or 97-percent nitrogen, 2-percent oxygen, and 1-percent argon. The instrument may also be used to indicate the presence of hydrocarbon vapor in the enclosure.

A pump for drawing a sample of gas into the instrument is located on the right-hand side of the case. This pump is operated by a detachable handle suspended from the case by a chain. (See fig. 9-3.)

Two cylinders containing chemicals are mounted on the left side of the instrument case.

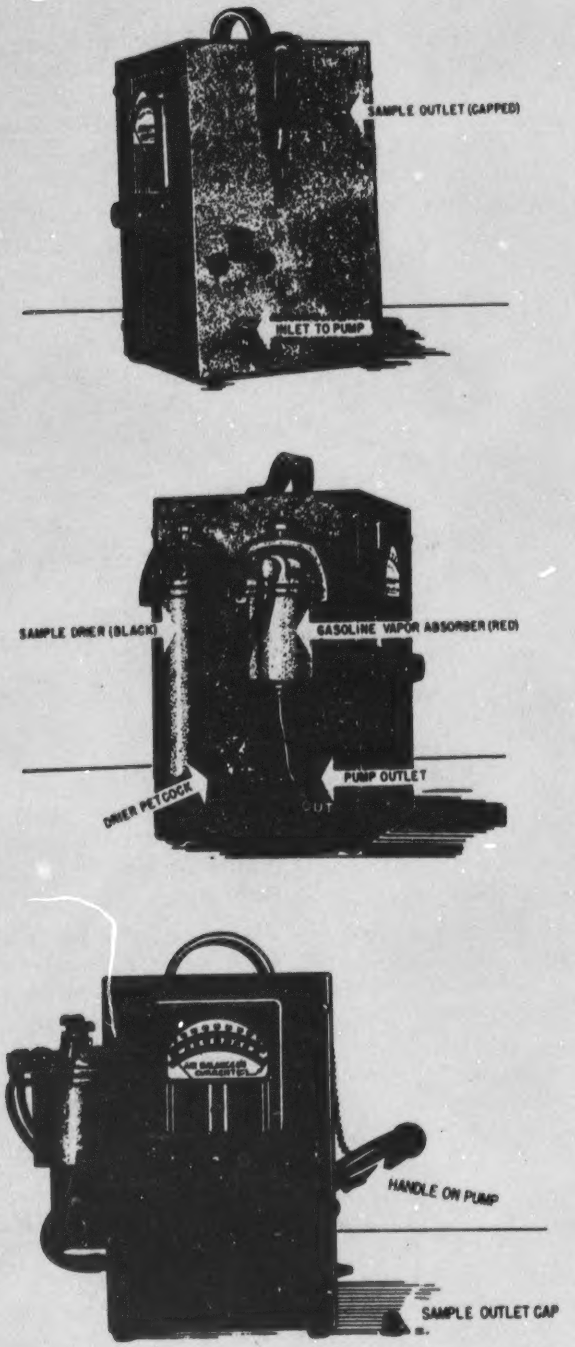

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Figure 9-3.—Portable inertness analyzer.

The smaller cylinder (colored red) contains activated carbon which absorbs hydrocarbon vapors. The larger cylinder (colored black) contains calcium chloride which absorbs moisture in the gas sample.

The controls, located on the front of the instrument, consist of a toggle switch and two rheostats (fig. 9-3). The positions on the toggle switch are marked A and C. Moving the toggle switch to position C supplies power for testing and regulating the battery current. When the analyzer is in operation, the toggle switch should be in position A.

The rheostat on the right side of the toggle switch is marked C and has ON and OFF positions. Its purpose is to regulate the amount of battery current. The rheostat on the left side of the toggle switch is marked A. This rheostat permits compensation to be made for filament wear. The indicating needle can be set to the ZERO mark on the dial by turning the control knob.

The indicator dial is located on the front of the instrument. This dial contains two scales. Inert gas mixtures (CO_2-N_2-O_2) are read on the inner scale. Nitrogen mixtures (N_2-O_2-A) are read on the outer scale, which is 50 percent of the inner scale.

To prepare the portable inertness analyzer for operation, proceed as follows:

1. Turn the current switch to "C" position.
2. Turn rheostat "C" to set needle at 100 on the scale.
3. Turn the current switch to the "A" position.
4. Open the petcock at the bottom of the drier.
5. Remove the hose to the petcock and attach the pump outlet hose to the petcock. (This cuts out the aviation fuel vapor absorber.)
6. Work the pump in fresh air for about one minute.
7. Turn rheostat "A" to set the indicator pointer at ZERO.

There are two analyzing procedures—one for enclosures which contain air and inert gas and one for enclosures which contain air, inert gas, and hydrocarbon vapor. For analyzing an enclosure containing a mixture of air and inert gas, the aspirating pump outlet is attached by means of a rubber hose to the drier inlet. The petcock on the inlet is opened. The pump inlet is attached to the sampling outlet of the enclosure. The aspirating pump is operated until the indicator pointer comes to rest (about 3 minutes). This reading is the percentage of inertness existing in the enclosure.

For analyzing an enclosure containing a mixture of air, inert gas, and hydrocarbon vapor, the outlet of the aspirating pump is connected to the inlet (bottom) of the vapor absorber. Another hose connects the outlet (top) of the vapor absorber to the inlet of the sample drier. After the petcock on the sample drier is opened, the aspirating pump is actuated until the indicator pointer comes to rest (about 6 minutes). This reading will be the percentage of inertness in the enclosure.

When there is doubt as to the presence of gasoline or other hydrocarbon vapors in an enclosure, it can be checked by using both methods. The method which directs the sample through the drier alone will give a higher or lower reading than the second method if vapors are present. When no vapors are present, both methods will give the same reading.

As a result of studies of the safety requirements for the stowage and handling of gasoline and similar hydrocarbon fuels aboard ship, NAVSHIPS has prescribed the following inertness values:

1. In compartments, piping, or cofferdams charged with nitrogen gas, an inertness of about 50 percent, as shown by the analyzer, will give full protection from fire, regardless of the amount of explosive vapor which may be present.
2. When charging with carbon dioxide, an inertness of 35 percent, as shown by the analyzer, will give full protection.

After each analysis requiring the use of the vapor absorber, it is advisable to purge this unit with air to remove the vapors. This is accomplished by attaching a rubber hose between the outlet of the aspirating pump and the outlet of the vapor absorber and actuating the pump for about 3 minutes.

Upon completion of the analysis, the petcock on the drier is closed, the rubber cap on the sample outlet replaced, and the toggle switch thrown to position C. If the current is 100 on the scale, rheostat C is turned counterclockwise until it clicks OFF. This completes the analysis.

CAUTION: After each analysis, close the petcock to the drier to preserve the life of the calcium chloride. For the protection of the instrument, always store it in the instrument box provided.

Complete instructions for maintenance, checks, and calibration of the instrument are included in the pamphlet provided with each instrument.

NOTE: After 50 analyses, examine the contents. If the calcium chloride has a glazed and hard appearance, replace it with a fresh supply. Also, replace the cotton pad on top of the chemical with a similar pad to prevent the contents from blowing away. When fastening the container in place, be certain the cork gasket fits properly.

Also, after 50 analyses, remove and reactivate the carbon in the red cylinder. This is done by heating the carbon in an open pan at 200° to 250° F for 1 hour in a well-ventilated space, but not over an open flame.

Another method of reactivating is to flush the carbon with cold, fresh water, Place it in a pipe and allow steam to pass through it for 1 hour. Make sure the reactivated carbon is DRY before returning it to the cylinder and be certain the cork gasket is in place.

The above mentioned procedures should be used only if new carbon is unavailable.

PORTABLE BLOWER (AIR TURBINE DRIVEN)

The air-driven portable blower is used to remove hazardous fumes and vapors from spaces that must be entered or other spaces into which these fumes have escaped. Fumes and gases are drawn into the blower and expelled through an exhaust hose to the outside of the ship.

Air from the low-pressure air system of the ship is directed against the blades of a turbine wheel (fig. 9-4). The force of the air acting against the blades causes the turbine wheel and shaft to rotate.

The turbine wheel is keyed to a shaft which extends through the turbine casing. It is provided with a stuffing box seal to prevent air leakage. Compressed air enters through a fitting at the top of the turbine casing, passes through the blading of the wheel, and is exhausted on the underside of the casing.

The shaft on which both the fan wheel and turbine wheel are mounted rotates in ball bearings which are lubricated from a grease reservoir. The fan wheel is in a fan housing provided with a screened circular intake at the end of the shaft. As the fan wheel rotates, air is drawn into the housing and discharged through the outlet. Connector rings for attachment of a duct or hose are provided on both the intake and discharge ports.

Collapsible hoses are connected to the blower when it is necessary to operate the blower some distance from the area being ventilated or when it is desired to ventilate the lower portion of a space. These hoses are 15 feet in length and may be folded like an accordion when not in use. The lengths may be connected to provide the length of hose desired.

CAUTION: In the operation of any portable blower, the discharge gases must be conducted to the outside of the ship. Under no circumstances should the gases be discharged into other spaces of the ship.

HOSE OR AIR LINE MASK

The Navy has authorized the use of a hose mask for firefighting and damage control work. (See fig. 9-5.) This mask is standard stock equipment and is included in the hull allowance list for most ships. The air line mask provides breathing and eye protection in spaces contaminated by any type of gas or vapor and where there is a lack of oxygen. All that is needed is an air line hose, which will give a continuous supply of pure air to the facepiece at a pressure slightly above the surrounding pressure.

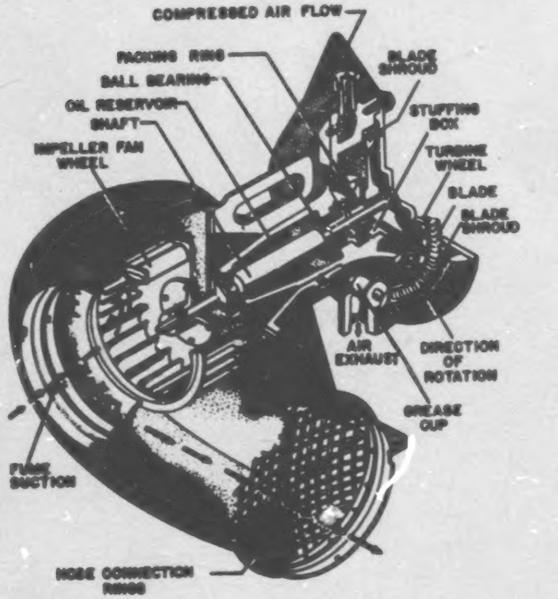

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Figure 9-4.–Portable blower.

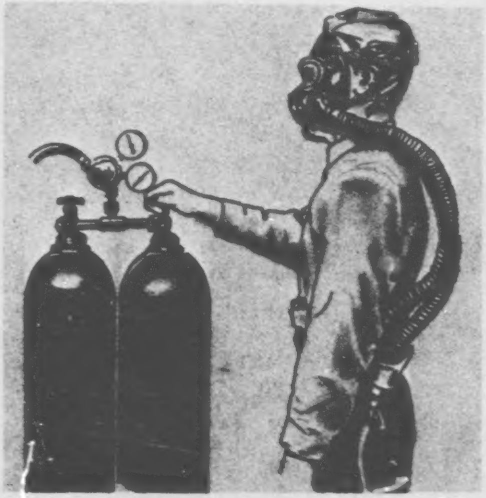

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Figure 9-5.–Air line mask, using compressed air cylinders.

The air line mask will be found useful on frequent occasions when conditions make it difficult to use the bulkier oxygen breathing apparatus. It should be part of every well-equipped repair party locker. One length of air hose (and of tender line) should be attached to the mask at all times, kept neatly coiled, and ready for instant connection to any of the available sources of air supply.

The most common source of air supply is the low-pressure ship's service line. It is advisable to run this air through an air filter before it enters the mask. The full supply of low-pressure air can be admitted to the control valve, and the wearer can regulate the flow to suit his needs. All excess air will escape around the face mask. Air can also be taken from an air flask. NEVER use an oxygen bottle with this equipment. A small amount of oil, grease, or oily water in the apparatus will combine with the oxygen, causing an explosion.

Before entering a space filled with toxic gases or smoke, check the hose mask to be sure it is working properly. Take a deep breath to determine whether the airflow is sufficient.

Repairs may be made from material contained in the regular gas mask repair kits on board.

Lifeline

Personnel wearing an air line hose mask when entering aviation gasoline stowage tanks, voids, etc., which contain toxic gases, must be equipped with a lifeline, and tended by a reliable man outside the space.

The Navy Standard Lifeline shown in figure 9-6 is a 50-foot nylon-covered steel-wire cable and is available aboard ship for use with the oxygen breathing apparatus or the air line mask. The tending line is equipped at each end with a stout hook that is closed with a snap catch. The line has a maximum of pliability and slides freely around obstructions.

The lifeline should be attached to the upper part of the body, preferably to the backloop of a shoulder harness. A cardinal rule is: NEVER attach a lifeline to the waist.

Tending lines are used as a precautionary measure to facilitate the rescue of an overcome investigator or fire fighter who is wearing an oxygen breathing apparatus, air line mask, or similar equipment. Rescue, if necessary, should be accomplished by having another man or men equipped with breathing apparatus, follow the tending line to the person to be rescued, rather than by attempting to drag the person out by the tending line. Attempts to drag a person out of a compartment by the tending line may very well result in the line becoming fouled on some obstruction or in parting the wearer's harness with a resultant loss of time, so that it will still be necessary to send a rescue man in. If rescue is to be effected promptly, a rescue man must, of course, be equipped with a breathing apparatus ready for immediate use and must be standing by ready for immediate entry.

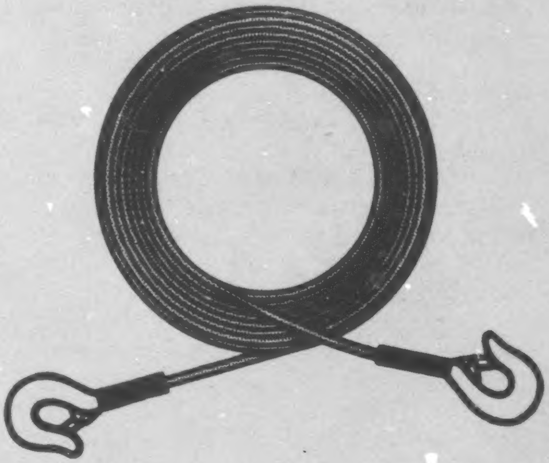

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Figure 9-6.—Tending line.

When any breathing apparatus is used in conjunction with a lifeline, a team of one wearer and one man to handle the tending line should work together. If it becomes necessary for two or more breathing apparatuses to be in use in the same space, the tending lines are not used, but each wearer should keep in constant sight or touch of one another.

When the lifeline is used, it is essential that the wearer and tender be able to communicate with each other. Standard diver's signals are normally used for this purpose; however, only the basic signals are needed for tank cleaners. These signals, with meanings modified to fit the tank cleaner situation, are as follows:

TENDER TO WEARER

Pulls on line	Meaning
1	Are you all right?
2	Advance.
3	Back out.
4	Come out immediately.

WEARER TO TENDER

Pulls on line	Meaning
1	I am all right.
2	I am going ahead.
3	Keep slack out of line.
4	Send help.

CAUTION: A stricken person must never be hauled by a line attached to his waist. He may be dragged a short distance along the deck, but his weight must never be suspended from his waist. If the wearer lacks any sort of shoulder harness, the line must be made fast so that it passes around the arms, and meets either in front or the back. The tender should wear rubber gloves and shoes when handling steel tending lines or cables.

NONSPARKING TOOLS

The aviation fuels repair team locker is equipped with a complete set of nonsparking tools. These tools are used in any space where there is danger of explosive vapors. See chapter 2 of this Rate Training Manual for further details on the use of nonsparking tools.

SOUND-POWERED TELEPHONES

The sound-powered telephone is an important part of the equipment used in the aviation fuels systems. It is discussed in this chapter since the drawing and the issuing of sound-powered telephones are normally handled through the aviation fuels repair team locker.

Purpose

The sound-powered telephone enables personnel of the gasoline crew who are designated as talkers to communicate with each other and with other members of the ship's crew and to transmit orders and instructions during aviation fuel handling operations.

Location

The telephones are normally stowed in waterproof lockers near each jackbox; the handsets are usually stowed between jamproof hooks. The telephones are portable and can be plugged into any of the jackboxes of the sound-powered communication system.

Description and Operation

There are two types of sound-powered telephones, the handset and the headset.

The handset resembles an ordinary telephone handset. The headset is adjustable to the wearer's head and chest. The transmitter and the junction box are supported on a chest plate by a double yoke with an adjustable thumb nut. The chest plate is suspended from an adjustable neck strap. The receivers are mounted on an adjustable headband and may be raised or lowered by loosening the thumb nuts that lock the sliding supports. An adjustable chinstrap holds the receiver firmly against the ears.

The transmitter case of the two types of sound-powered telephones is plastic and contains a diaphragm and a permanent magnet assembly of the balanced armature type. The talker's voice causes the sensitive diaphragm to vibrate. The diaphragm moves the armature back and forth in the field of the permanent magnet, causing variations in the magnetic field within the armature, and thus generating an alternating potential in the magnet coils surrounding the armature.

Normally, the transmitter is disconnected from the circuit to eliminate noise pickup which would disturb others using the circuit.

In the headset, a pushbutton switch mounted on the upper side of the transmitter is used to connect the transmitter. In the handset, a pushbutton on the handle performs the same function.

The receiver case of the two types is also plastic. The internal construction is similar to that of the transmitter, but the winding of the magnet coils is the reverse of the transmitter magnet winding.

The sound-powered telephone will not operate on a battery-powered circuit and should never be plugged into such a circuit. To put the telephone into operation, the jack plug on the end of the 20-foot extension cord is plugged into one of the jackbox outlets. The talker must speak distinctly, hold the transmitter close to his mouth, and press the circuit button switch down firmly to ensure good electrical contact.

CAUTION: A sound-powered telephone, whether a headset or a handset, should never be handled by its cords; such careless handling will result in broken wires and a shorted instrument.

INSPECTION OF WORK AREAS, TOOLS, AND EQUIPMENT

Personnel involved in any operation where there is a danger of aviation fuel or aviation fuel vapor must observe the following safety rules:

1. Smoking or carrying lighted cigarettes, cigars, or pipes where aviation fuel is present is prohibited. No exposed flame of any kind is permitted in the vicinity of tanks, pipes, or areas where aviation fuel is present. Matches and automatic lighters must not be in the possession of personnel entering these spaces.
2. Equipment used in handling aviation fuel must be checked periodically. Make sure that fittings, pumps, and valves are not leaking and are lubricated according to instructions.
3. In making repairs or doing other work on or near aviation fuel handling equipment, use only tools of nonsparking materials, such as brass, wood, or plastic.
4. Do not wear shoes which have exposed nails or sand embedded in the heels or soles.
5. Electrical equipment used where aviation fuel is present must be explosionproof. Electric lights, fixed or portable, must be explosionproof, and lamps and sockets must be protected with globes and wire guards.
6. All hose, piping, and containers which are used in handling aviation gasoline must be emptied, ventilated, and charged with an inert gas or CO_2 upon securing from these operations.
7. Do not handle aviation gasoline in open containers, or in enclosed spaces.
8. If aviation gasoline or gasoline vapor is spilled or escapes in an enclosed space, ventilate the area immediately by approved methods. If there is considerable vapor, empty the space of all personnel and ventilate the area thoroughly.
9. Only trained personnel, wearing proper breathing apparatus and being properly tended by other men, should enter a space filled with aviation gasoline vapors.
10. No space should be entered until the condition of the air inside has been determined to be safe by tests with a combustible gas indicator and a flame safety lamp.

All safety precautions are listed in chapter 9150 of NAVSHIPS Technical Manual.

AVIATION GASOLINE

Aviation gasoline vaporizes quickly, and the vapor mixes readily with air. Such mixtures are explosive if the proportions of gasoline vapor and air are within certain limits. The lower limit is about 1.4 percent of gasoline vapor in the air by volume. The upper limit is about 6.0 percent.

If a closed gasoline tank is completely full of liquid, no gasoline vapor can form. If a closed tank is partly full of gasoline, the vapor will accumulate in the remaining space to a pressure which depends on the temperature of the tank.

As long as a tank remains sealed, there is no danger. If a tank containing gasoline is opened, vapor will rise from the liquid and form a combustible mixture with the surrounding air. Such mixtures will explode if ignited by a spark or flame.

Gasoline will burn freely without explosion if ignited immediately after it is spilled and before there is time for the formation of more than a small volume of explosive mixture. A fire on or near a tank of gasoline having a small opening may generate enough heat and vaporize the gasoline too rapidly for an explosion to occur inside the tank. The vapor thus generated will issue from the opening at a high rate and burn as it mixes with the air. If the opening is too small, the vapor pressure may build up and burst the tank.

Gasoline vapor is heavier than air. If gasoline has leaked into a compartment, the highest concentration of vapor will be near the bottom. The vapor will gradually spread throughout the compartment(s), particularly if the air is kept in circulation by personnel moving about. A dangerous feature of gasoline vapor is that it may travel along with a current of air for a considerable distance through several compartments or levels in a ship. If it is then ignited, the flash will travel back to the source of the vapor and cause an explosion or fire at some distance from the point of ignition.

Gasoline vapor and air mixtures are easily ignited by an open flame or by sparks. Sparks may be caused by faulty electrical equipment; by the operation of ordinary electrical switches; by the striking of two pieces of steel together, such as a wrench and bolt; by shoe nails or sand embedded in shoes striking against a steel deck; or from static electricity.

It is hazardous to inhale gasoline vapor or to wet the skin with gasoline. Aviation gasoline contains tetraethyl lead which is poisonous to the human system. The ethyl fluid also vaporizes and is present with gasoline vapor. The compound may enter the body through inhalation, by absorption through the skin, and through the mouth. If gasoline is swallowed, do not induce vomiting. Seek immediate medical aid. Therefore, contact with liquid gasoline and inhalation of gasoline vapor should be avoided.

For further details on the characteristics of aviation fuels, see chapter 3 of this training manual.

JP-5 JET FUEL

Although JP-5 jet fuel has a relatively low vapor pressure and does not vaporize as readily as gasoline at compartment or ambient temperatures, it is important to remember that it will burn readily at these temperatures; therefore, it must be handled with great caution. The precautions to be observed in the handling of aviation gasoline are equally well applicable to the handling of JP-5.

Other safety precautions to be observed during the handling of aviation fuels are given in chapters 5 and 6 of this training manual.

REPAIR OF PIPING SYSTEMS

Early detection and correction of piping defects are of the utmost importance, since the operational reliability of ships requires that all piping systems be in satisfactory operating condition. Damage to piping systems may result from battle or accident, or merely from the wear and tear of daily use. The ABF should know how to locate and repair piping system troubles.

Repairs to piping are classified as permanent or temporary. Permanent repairs are made when the same material as the ruptured piping is available and the system can be secured for the time needed to make the repair. Temporary repairs are made, however, when the material is not available and/or the system cannot be secured.

TEMPORARY REPAIRS

Temporary repairs are usually made by securing some type of patch over the damaged section of pipe. The material used for the patch depends upon the type of piping that is being repaired. A good general rule to go by is to make the temporary patch from the same type of material that is used for the flange gaskets in the system. Back up the patch with a piece of sheet metal, and secure the sheet metal to the pipe with bolted metal clamps or similar devices. A sealing compound may be applied between the patch and the pipe to help seal the patched area.

For low-pressure sea water piping, red lead wrapped around the pipe with canvas and served with marlin or electrical tape makes an excellent, easily applied patch. A small leak in this kind of piping can often be stopped by driving in a soft pine plug. The moisture will cause the wood to swell and remain in place.

Small holes in some piping may be temporarily repaired by drilling and threading and inserting a screw.

Temporary patches may also be made from portland cement, cast in place and secured by metal bands. On low-pressure water piping, a portland cement collar can be cast entirely around the pipe. Iron cement can be used effectively to make temporary patches on low-pressure piping made of iron or steel.

Jubilee pipe patches, shown in figure 9-7, are frequently used to stop leaks in piping. These patches may be obtained from standard stock, or they may be fabricated on board ship. When making up a patch of this type, be sure to reinforce the flange so that it will be strong enough to hold against the pressure of the system.

NOTE: The main disadvantage of the Jubilee patch is that assorted sizes must be stocked since each patch is manufactured to fit only one size of pipe.

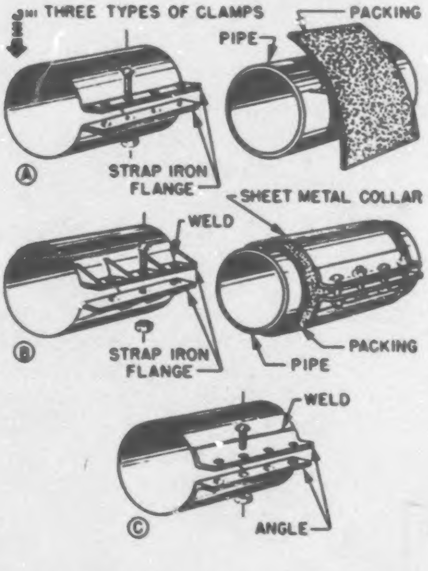
THREE TYPES OF CLAMPS
PACKING
PIPE
Ⓐ
STRAP IRON FLANGE
SHEET METAL COLLAR
WELD
Ⓑ
STRAP IRON FLANGE
PACKING
PIPE
WELD
Ⓒ
ANGLE

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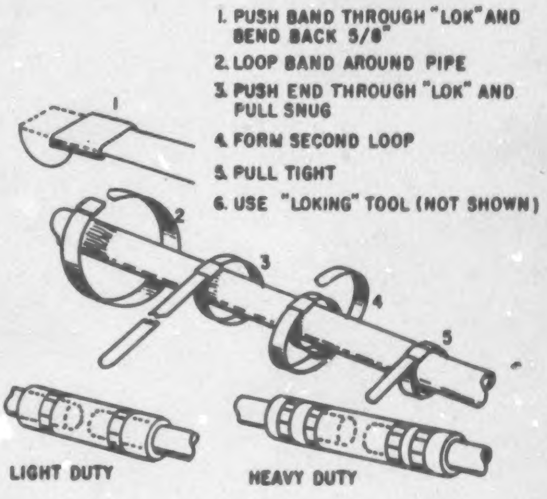
Figure 9-7.—Jubilee pipe patches.


1. PUSH BAND THROUGH "LOK" AND BEND BACK 5/8"
2. LOOP BAND AROUND PIPE
3. PUSH END THROUGH "LOK" AND PULL SNUG
4. FORM SECOND LOOP
5. PULL TIGHT
6. USE "LOKING" TOOL (NOT SHOWN)
1
2
3
4
5
LIGHT DUTY
HEAVY DUTY

197.64

Figure 9-8.—Pipe banding.

Pipe banding toolkits are available in repair lockers. These kits may be used in the manner shown in figure 9-8 for the emergency banding of pipe patches.

Temporary repairs to some piping systems may also be made by using the rather new plastic patching materials. The materials required for plastic patching are furnished in a special kit. This kit and its use are described in the next section of this chapter.

Emergency Damage Control Metallic Pipe Repair Kit

Most water and aviation fuel lines can be easily repaired and service restored to the system in as little time as 30 minutes by the use of the emergency damage control metallic pipe repair kit, often referred to as the plastic patch. In addition to the repair or patching of piping, certain materials are included in the kit which may be utilized to patch small cracks and ruptures in flat metal surfaces.

Kit Contents

These materials in the kit may be obtained separately through appropriate supply channels whenever a need arises to replace them; you need not obtain another completely new kit. A complete kit contains the following materials:

4 cans liquid resin, 400 grams each
4 cans liquid hardener, 100 grams each
4 cans paste resin, 300 grams each
4 cans paste hardener, 75 grams each
1 piece woven roving cloth 24" x 10"
1 piece void cover, 8" x 36"
1 piece Polyvinyl Chloride (PVC) film, 36" x 72"
1 chalk line, 1/8-lb
4 pair of gloves
2 eyeshields
4 wooden spatulas
1 sheet of emery cloth, 9" x 11"
1 scissors
4 tongue depressors
1 Instruction Manual

A description of the basic materials and factors related to plastics is necessary for you to more thoroughly understand the discussion of the kit and its use.

RESINS AND HARDENERS.–The liquid and paste resins are of the epoxy type. The liquid and paste hardeners are chemical compounds used to harden the resins. The resins and the hardeners are packaged in premeasured amounts. For proper mixture and better results the complete contents of the hardener in the smaller can should be mixed with the complete contents of the resin in the larger can. CAUTION: DO NOT MIX HARDENER WITH RESIN UNTIL ALL PREPARATIONS HAVE BEEN COMPLETED, AND DO NOT INTERMIX LIQUID RESIN AND PASTE HARDENER OR PASTE RESIN AND LIQUID HARDENER.

When the hardeners and the resins are mixed, a chemical reaction occurs which causes the mixture to harden (liquid mixture, approximately 12 minutes; paste mixture, approximately 17 minutes).

VOID COVERS.–The void cover is resin-treated glass cloth that can be cut and formed to cover the damaged area and is sufficiently rigid to give support to the patch.

WOVEN ROVING CLOTH.–The woven roving cloth is made of a short staple glass fiber woven into a thick fluffy cloth. During the application of a plastic patch this cloth is coated with the resin-hardener mixture and either wrapped around or placed over the damaged area. The glass cloth provides the main strength of the patch and at the same time provides a means of applying the resin-hardener mixture.

FILM (PVC).–The plastic film is a thin transparent polyvinyl chloride material that is used as a separating film for the flat patch to prevent the patch from sticking to the backup plate or other supports. It is referred to as PVC. In the pipe patch it is used to cover the entire patch and retain the activated resin around the patch. Kraft wrapping paper may be used as a substitute if necessary.

When the resins and the hardeners are mixed together, a chemical reaction begins. This reaction is exothermic, which means that heat is given off. For approximately 12 to 17 minutes the temperature increases gradually until it reaches 120° to 135° F. At this temperature a sudden, sharp increase in temperature occurs until it reaches its peak at about 350° F. This sudden sharp rise in temperature is known as "kick-over." It is at this temperature that the resin-hardener mixture begins to solidify and change color from gray to light brown. The peak temperature (350° F) can be observed through the external change of the patch.

The resin-hardener mixture begins to cool slowly due to the poor thermal conductivity of the materials. After kick-over, the mixture continues to harden and increase in strength. This process is referred to as "curing." Approximately 30 minutes after kick-over (the sharp rise in temperature) the patch is strong and hard and cool enough to use. Pressure should not be restored to the system until the patch has cured. The patch is considered sufficiently cured when the bare hand can be placed on it without discomfort from heat.

There are several factors that contribute to the control of kick-over; the most important factor is the temperature. Both the initial temperature of the activated resin mixture and the temperature of the atmosphere affect the kick-over time. Of these two temperatures, however, the initial temperature of the activated resin has the greater effect. When the temperature of the resin and the hardener prior to mixing is increased, the kick-over time decreases. Conversely, when the temperature of the resin and hardener prior to mixing decreases, the kick-over time increases.

A knowledge of the control of kick-over is necessary since it corresponds to application of working time. This means, for example, that when the initial temperature of the mixture is 73° F, the patching material must be placed over the rupture within 12 minutes. Once the resin and the hardener are mixed together the chemical reaction cannot be stopped. Therefore the patch should be completely applied before kick-over occurs.

Figure 9-9 illustrates the relationship of the kick-over time to the resin temperature. If you know the resin temperature at the time of mixing, you will be able to determine the amount of time available to apply the patch before kick-over occurs. Referring to figure 9-9, you can see that if the resin temperature is 80 degrees (point A), the kick-over will occur in less time than if the resin temperature was 60 degrees (point B). The difference in resin temperatures represents an application working time of 9 minutes versus 18 minutes.

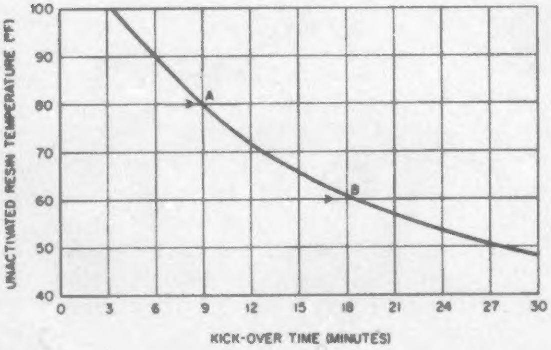


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Figure 9-9.—Resin temperature vs kick-over time.

NOTE: If the initial resin temperature exceeds 80° F the temperature should be reduced by artificial means to 73° F, prior to mixing. This lowering of the temperature allows for additional application working time.

Advantages of the Plastic Patch

From the damage control viewpoint the main advantages of the plastic patch are (1) versatility, (2) simplicity, (3) effectiveness, (4) speed of application, and (5) durability.

The plastic patch can be successfully applied to a variety of damaged surfaces, whether with smooth edges or jagged protruding edges. Since the plastic has excellent adhesive qualities it can be readily applied to steel, cast iron, copper, copper-nickel, brass, bronze and galvanized metals.

The preparing of the plastic materials and the application of the plastic patch are readily performed. By following the instructions outlined in the instruction manual that is included in the kit, a man with little or no experience can readily prepare the materials and apply a plastic patch. The application of a plastic patch is comparable to a battle dressing used in first aid.

If the materials are properly prepared and the application procedures are duly followed, the plastic patch will be 100 percent effective. If leakage occurs through a plastic patch, it is likely that proper preparation and application procedures have not been followed.

The speed of application will vary somewhat with the size and the type of rupture and also with local working conditions. When proper preparation procedures are followed, a simple patch can be applied to a 4-inch pipe by an inexperienced crew, who have had the minimum amount of training and indoctrination, in 10 minutes or less. The type and the size of the rupture, or the shape and the size of the structure to which the patch is applied do not materially affect the time involved in patching; but some types of damage may require more initial preparation.

The maximum period of effectiveness of a plastic patch is not known, but all indications are that a properly applied patch will last indefinitely, or certainly until such time that permanent repairs can be made. The patch is relatively inert, being seriously affected only by excessive heat and concentrated acids.

Application of Plastic Patches

In the following discussion on applying different types of plastic patches (simple, elbow, severed and others) you will readily see that as the individual patch materials are applied, the patch becomes progressively wider. The sketch shown in figure 9-10 illustrates the relative positions of the patch materials to one another. The buildup in the patch length during application must be considered in initially determining the length of the patch to be applied. Where suitable, allow the patch to extend at least 4 to 5 inches on either side of the rupture.

In addition to the size of the rupture, the width of the patch may also depend upon the location of the rupture in the pipe system. For example, an elbow rupture may require a patch of greater width than the same size rupture would require in a straight section of pipe. Complete application instructions are included in each kit.

Preparation

Prior to the actual application of the plastic patch, the following preparations must be made:

1. Secure or isolate the ruptured area in the piping system.

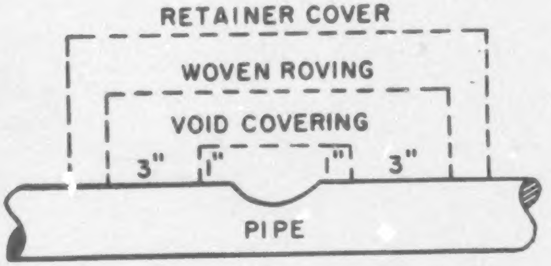

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Figure 9-10.–Sequence of applied patch materials.

2. Remove all lagging.

3. Clean the area around the rupture and remove all grease, oil, dirt, paint, and other foreign matter. If grease or oil is present, use an approved solvent such as Stoddard Solvent or methyl chloroform. If this solvent is not available, scrape and wipe the surface until it is clean. When a clean surface is obtained, the surface may be further abraded for better adhesion. An abrasive cloth is furnished with the kit.

4. Ensure that all water and moisture are removed from the inside of the piping and the entire pipe surface is dry.

5. Where practical, the rupture should be simplified by bending or removing irregular projections. This may be accomplished by cutting or burning. CAUTION: IT IS OF THE UTMOST IMPORTANCE THAT NO EXPLOSIVE CONDITIONS EXIST PRIOR TO USING SPARK-PRODUCING TOOLS OR BURNING EQUIPMENT.

6. Determine the amount of materials that will be required, such as the amount of woven roving cloth, and the amount of resins and hardeners. For example, a 2-inch rupture in a 2-inch diameter pipe will require 500 grams of activated resin and a length of woven roving cloth that is at least 25 inches long. Cut the woven roving cloth, in width, to extend at least 3 to 4 inches on either side of the rupture.

SIMPLE PIPE PATCH.–The following numbered instructions are step-by-step procedures for applying the simple pipe patch.

1. Put on the eyeshields and the gloves; then open the liquid resin can and the liquid hardener can.

2. Add hardener to the resin and mix thoroughly for approximately 2 minutes or until a uniform gray color is observed. (Note that the entire contents of the liquid hardener in the smaller can is the correct proportion for mixing with the entire contents of the larger can of liquid resin.)

3. Coat both sides of the void cover with the resin hardener mixture and tie the void cover over the rupture with chalk line as shown in part A of figure 9-11.

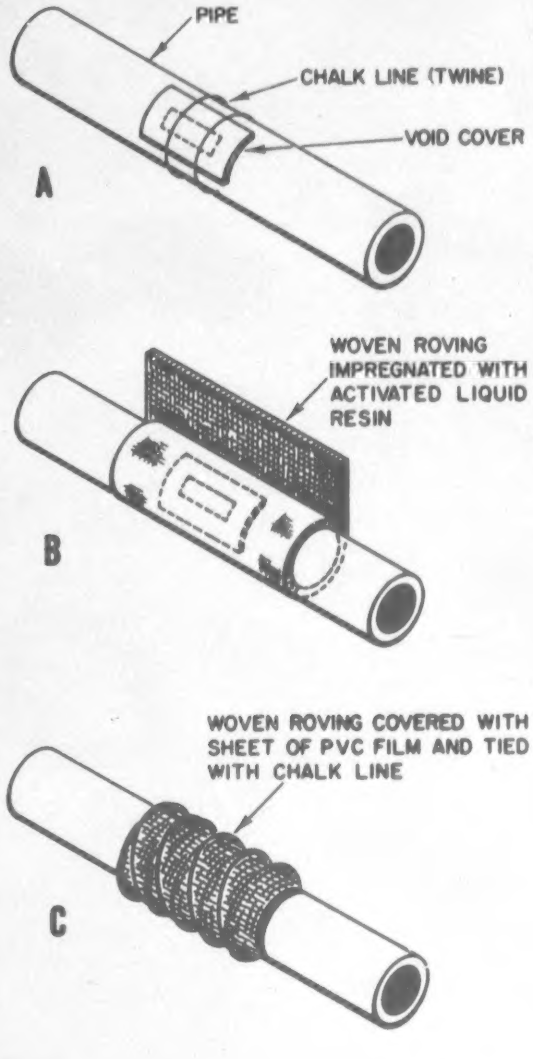
PIPE
CHALK LINE (TWINE)
VOID COVER
A
WOVEN ROVING IMPREGNATED WITH ACTIVATED LIQUID RESIN
B
WOVEN ROVING COVERED WITH SHEET OF PVC FILM AND TIED WITH CHALK LINE
C
197.65

Figure 9-11.—Simple pipe patch.

4. Lay the woven roving cloth on a clean flat surface. Starting at one end of the cloth, pour on resin-hardener mixture and spread evenly over the entire surface of the cloth using the spatula provided in the kit. It is only necessary to impregnate one side of the woven roving cloth; but care should be taken to ensure that the edges are well impregnated with the resin-hardener mixture.

5. Center the woven roving cloth over the void cover with the impregnated side toward the pipe and wrap around the pipe not less than 3 turns and preferably not more than 4 turns. See part B of figure 9-11.

6. Wrap the PVC film around the entire patch making at least 2 complete turns. Tie the PVC film with the chalk line, starting from the center of the patch and working toward one end, making 1/2-inch spacings between spirals (part C of fig. 9-11). Tie this end securely but do not sever the line. Make one spiral back to the center of the patch, then working to the opposite end from the center of the patch, make 1/2-inch spacings between spirals and again secure the line. After 30 to 40 minutes the patch should be sufficiently cured to restore the pipe to service.

7. Remember that for best results the temperature of the liquid resin and the liquid hardener, before mixing should be approximately 70° F. With a temperature of 70° F at the time of mixing, the patch will cure approximately 1 hour from the initial mixing time; and after this hour pressure may be restored to the piping system.

8. In emergencies, if the temperature of the resins and the hardeners is below 50° F, kick-over may be accelerated by applying external heat with hot air heaters, infrared lamps, or light bulbs. The external heat must be applied gradually because excessive application of heat will cause the plastic patch to be extremely porous. (Where possible, it is better to warm the resin and hardener in the can before mixing, to an approximate temperature of 70° F.)

9. Care must be taken not to restore pressure to the piping system too soon. In general, pressure may be restored when you can hold your hand on the entire patch area without discomfort resulting from heat; normally this may require between 30 to 40 minutes after kick-over, or 50 to 60 minutes from the initial mixing time.

10. In emergencies, 15 minutes after kick-over, the liquid in the piping system may also be used as an artificial cooling medium. This is accomplished by circulating the liquid at very

low pressure (not above 10 psi) through the system for approximately 5 minutes. This procedure will generally reduce the time, by approximately 15 minutes, before full pressure can be restored to the system.

The sketch shown in figure 9-10 illustrates the relative positions of patch materials to one another. This buildup in the patch during application must be considered in initially determining the length of patch to be applied.

ELBOW PATCH.–The elbow patch shown in figure 9-12 is applied using the same basic procedures as the simple patch, but with the following exceptions:

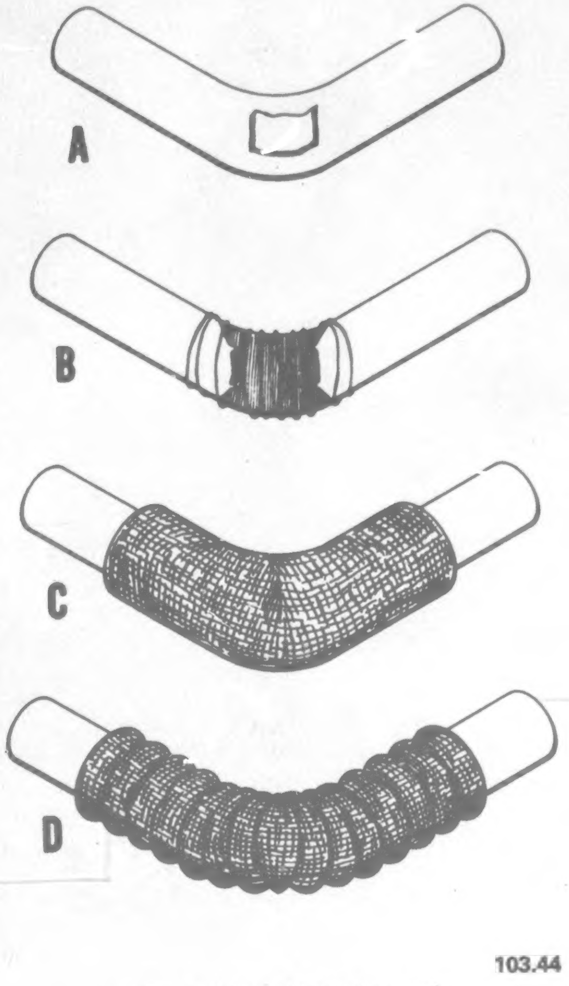

Figure 9-12.–Elbow pipe patch.

1. The edges of the void cover are slit 2 to 3 inches at each end to conform to the contour of the pipe. See part B of figure 9-12.
2. After the impregnated woven roving cloth has been wrapped around the pipe, use the gloved hand to shape the cloth to the contour of the pipe.
3. Then apply the PVC film and tie it with the chalk line as described for the simple pipe patch.

SEVERED PIPE PATCH.–The severed pipe patch shown in figure 9-13 is also applied with the same basic procedures as the simple pipe patch; but this procedure too has some exceptions:

1. Where the gap exceeds 4 inches, thin sheet metal, 1/16-inch asbestos, or other suitable materials may be used as a substitute for the void cover in bridging the gap. The substitute material should be cut so that it will extend at least 2 inches on either side of the gap and should be long enough to provide one complete turn around the pipe with a possible overlap of about 2 inches. Secure the substitute material with the chalk line.
2. Cut the woven roving cloth so it will extend at least 4 inches beyond the edges of the bridge material. Impregnate the cloth with the resin-hardener mixture. Wrap the cloth around the bridge materials and tie it securely as you did for the simple pipe patch.
3. Apply the PVC film and tie it securely with the chalk line as you did for the simple pipe patch.

COMPOUND PATCH.–When effecting repairs resulting from battle damage to piping systems, the compound type rupture, as shown in figure 9-14, will undoubtedly be more frequently encountered. Since compound ruptures may take a variety of shapes, it becomes difficult to select a single example to fit all repairs. In most compound ruptures it should be possible to simplify the rupture by removing butterfly edges, or by cutting away the damaged section to form either a severed pipe or

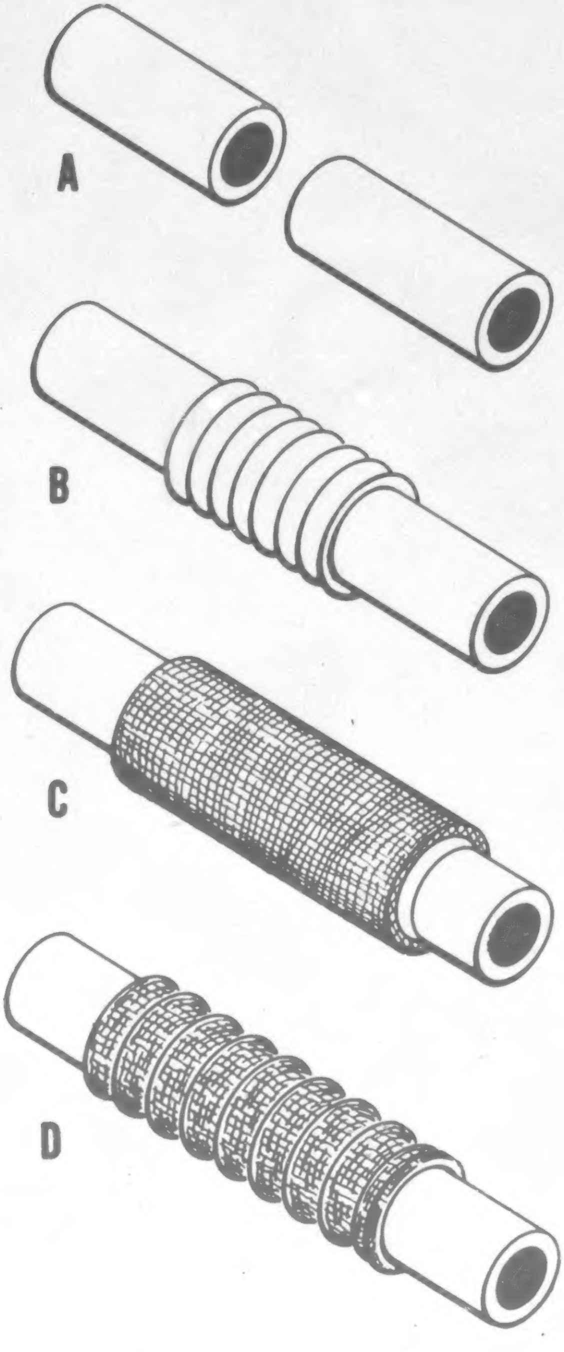

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Figure 9-13.—Severed pipe patch.

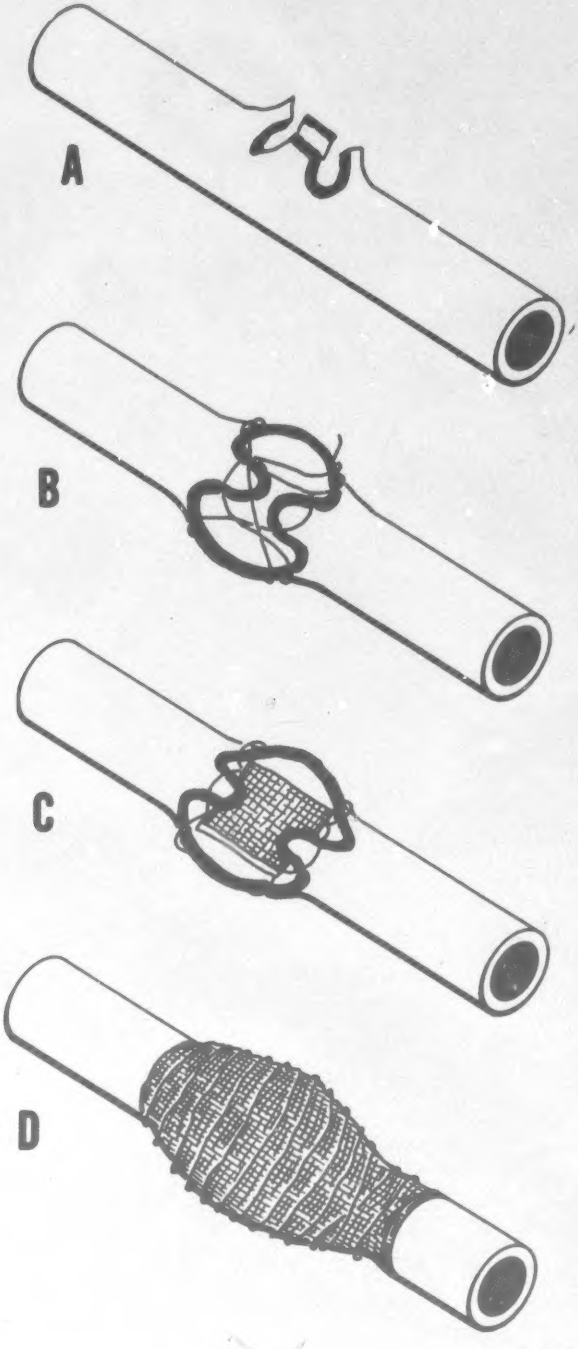

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Figure 9-14.—Compound rupture patch, edges not removed.

a simple pipe repair. When the butterfly edges or other projections cannot be removed by pounding in, cutting or burning, a simple pipe patch may be applied with the following modifications:

1. Tie the chalk line firmly between the jagged edges (part B of fig. 9-14) crisscrossing as much as possible. This chalk line acts as a support for the woven roving cloth and keeps it from falling into the void. No void cover is used in this example as it would be impractical to cut a void cover to suit the jagged edges shown in part A of figure 9-14.

2. A small piece of impregnated woven roving cloth, shown in part C of figure 9-14, is folded and laid in the void where it helps to build up the mass and acts as an insulator.

3. Apply the woven roving cloth, as shown in part D of figure 9-14, which has been cut to the appropriate length and width, over the small folded piece of woven roving cloth and tie it firmly as outlined previously for the simple pipe patch.

FLANGE PATCH.–The flange patch (fig. 9-15) is also applied similarly to the simple pipe patch, but it has some modifications in the application procedure.

1. As illustrated in part B of figure 9-15, the void cover is cut into an H shape, impregnated with the resin-hardener mixture, inserted into the void, and tied securely in place.

2. Four pieces of woven roving cloth are cut long enough to make one complete turn around the pipe and overlap 1 inch. These four pieces of woven roving cloth are cut in an H shape, but the center pieces are not cut away. Instead, they are folded up over the edges of the flange.

3. Impregnate the separate plies of woven roving cloth with the resin-hardener mixture and place over the rupture, as shown in part C of figure 9-15.

4. Apply the PVC film and tie down firmly, starting at one end and working up to the flange. Make several windings through the gap in the flange in a figure X in order to have the woven roving cloth conform to the center of the rupture and the flange edges. Continue on to the opposite end of the patch and tie securely in place.

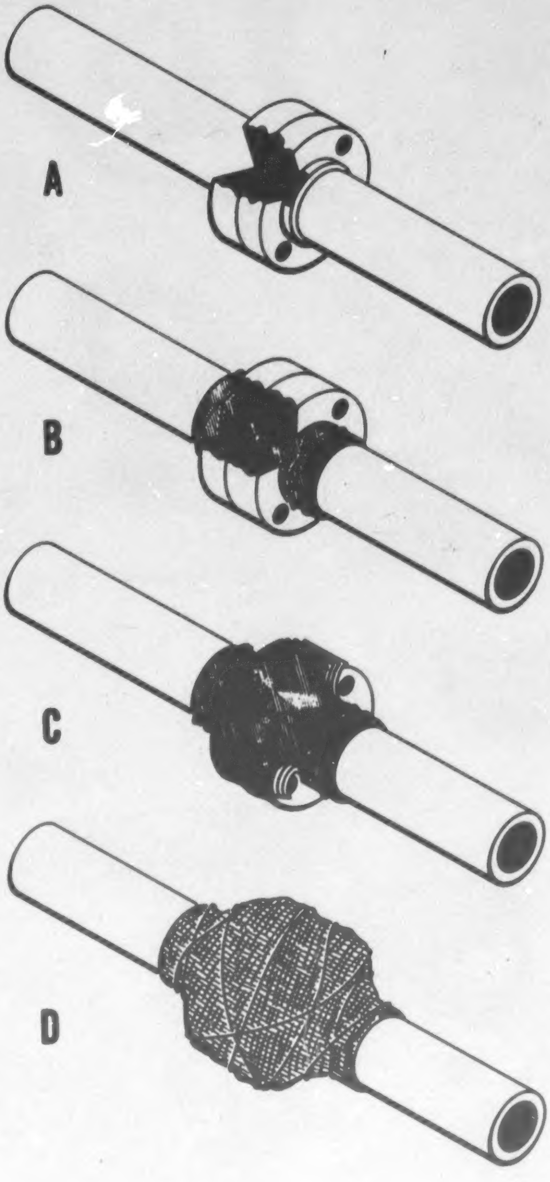

Figure 9-15.–Flange rupture patch.

Safety Rules

The following safety precautions should be observed by all personnel when working with plastic materials:

1. Provide forced intake and exhaust ventilation; this is particularly important when heat and resultant fumes are given off.
2. Wear long sleeve coveralls, long sleeve neoprene gloves, knee-high rubber boots, and goggles.
3. Immediately relieve and treat anyone evidencing sensitization.
4. Wash hands frequently. (Personal cleanliness is your most important and effective protection.)
5. Do not expose yourself to or breathe the noxious fumes given off during cure.
6. Avoid spilling plastic materials. Keep kraft paper in areas where material is likely to spill or drip.
7. Keep the resin and liquid hardener off skin areas, wherever possible. Use protective ointment. If contaminated, remove material as soon as possible, using soap and hot water.
8. Keep the resin and liquid hardener out of the eyes. If contaminated, immediately flush with water for at least 15 minutes and obtain medical treatment.
9. Wash gloves and goggles immediately after each use with a good detergent.

Aboard ship, these precautions should be taken insofar as possible but not to such an extent as to delay vital repair measures. Reasonable care in the handling of materials and thorough washing after their use should suffice. Since it appears that resins and liquid hardeners do not have primary irritant qualities, they may be used aboard ship without expecting any trouble, except a possible rare case of sensitivity.

Summary

An ideal plastic patch is one which can be applied and cured in the shortest time possible and will maintain the desired tightness. The primary factor controlling kick-over time is the temperature of the resin and hardener prior to mixing. In order to effect the cure in the shortest time possible it is necessary to contain the heat generated in the patch. This is done by creating a mass about the break in the pipe or bulkhead rupture by the use of an impregnated woven roving cloth. You can see, therefore, that the correct amount of mass is necessary in order to have an effective patch. It is also important that the patch cool readily, for you cannot restore pressure to the system until the patch cools to about 150° F. The net result is that you build up a mass about the rupture that will give you the patch with the most desirable characteristics in the shortest time possible.

PERMANENT REPAIRS

A repair is considered permanent if it restores the piping system to its original serviceability and if it can be expected to last for the life of the system.

Permanent repairs may be made in various ways, depending upon the nature of the damage, the operating conditions of the system, and the material of which the system is made. Probably the most common type of permanent repair is the complete replacement of an assembly. However, damage that is not serious enough to require the replacement of an entire section can often be repaired permanently by other means, such as patching, tightening joints, and repacking valves.

Permanent repair work requiring burning and welding is accomplished by the ship's engineering department or at a shipyard. However, V-4 division personnel may be called on for assistance.

FLANGE SAFETY SHIELDS

All JP-5 piping and valve flange joints located in heat-producing areas such as firerooms, boilerrooms, etc., must be equipped with flange safety shields. (See fig. 9-16.)

In the event of a blown gasket or ruptured flange when the system is pressurized, the safety shields will contain the JP-5 within the immediate area of the bilge.

Pipe flange safety shields acting as a leakage interceptor are designed to wrap around a pipe

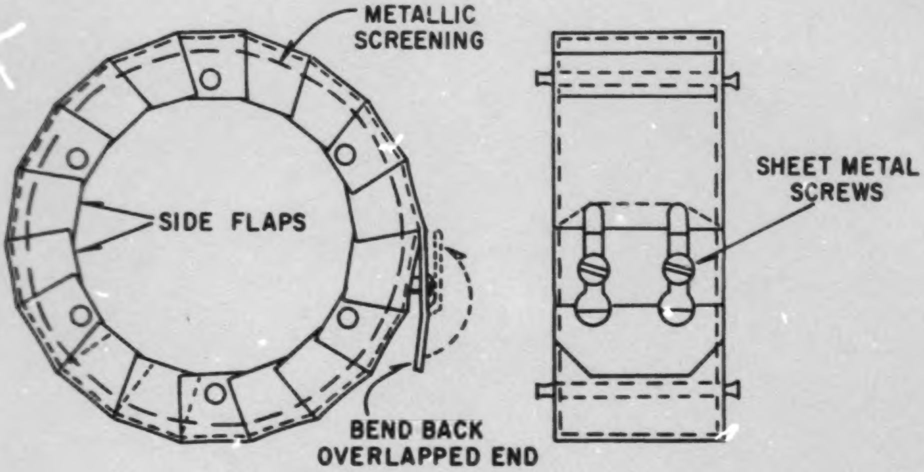

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Figure 9-16.–Flange safety shield, (sheet metal).

flange fitting. Each sheet metal unit has an extended flap at one end with keyhole slots that button into two receiving screws. The body of the shield is formed to the shape of a channel with closely spaced overlapping segments as legs and spacing rods anchored between them to hold the shield equidistant at all points from the periphery of the pipe flange.

A galvanized steel wire cloth liner no coarser than 14 x 16 mesh with 0.011-inch wire is affixed to the inside of the shield between the spacing rods and the inside shield surface for the purpose of reducing lateral aerosol mist. The use of sheet metal shields is restricted to systems operating with less than 600 psig.

The latest designed flange shield shown in figure 9-17 was developed to eliminate spray from leaking mechanical pipe joints in flammable-liquid lines where the lines' contents are at a temperature of 200° F or less and the maximum pressure is 1,000 psig. This shield is constructed of aluminized glass cloth and may be obtained through the Navy supply system.

FLANGED JOINTS

At regular intervals, the joints in the piping systems should be inspected for leakage. A small amount of seepage at a joint may not seem important; but if the trouble is not corrected, the leak is likely to become greater and create hazardous conditions.

Leakage at flanged joints may often be corrected by tightening the flange bolts. If tightening does not stop the leak, disassemble the joint. In some joints, renewing the gasket will stop the leak; in other joints it will be necessary to reface, resurface, or renew the flange.

When renewing the gaskets, be sure to use the material appropriate for the pressures and type of liquid being used in the system. Buna-N-Cork gasket material is used throughout the JP-5 and AvGas piping system.

Before renewing a gasket, clean the flange faces carefully, removing traces of scale, grease, and other foreign matter. If the flange faces are eroded or uneven, they must be refaced before making up the joint.

Most flanged joints require full-face gaskets–that is, gaskets in which the outside diameter of the gasket is equal to the greatest flange diameter. To mark gasket material for cutting a full-faced gasket, lay the sheet packing over the flange, if practicable, and then mark the location of the boltholes and the inner and outer

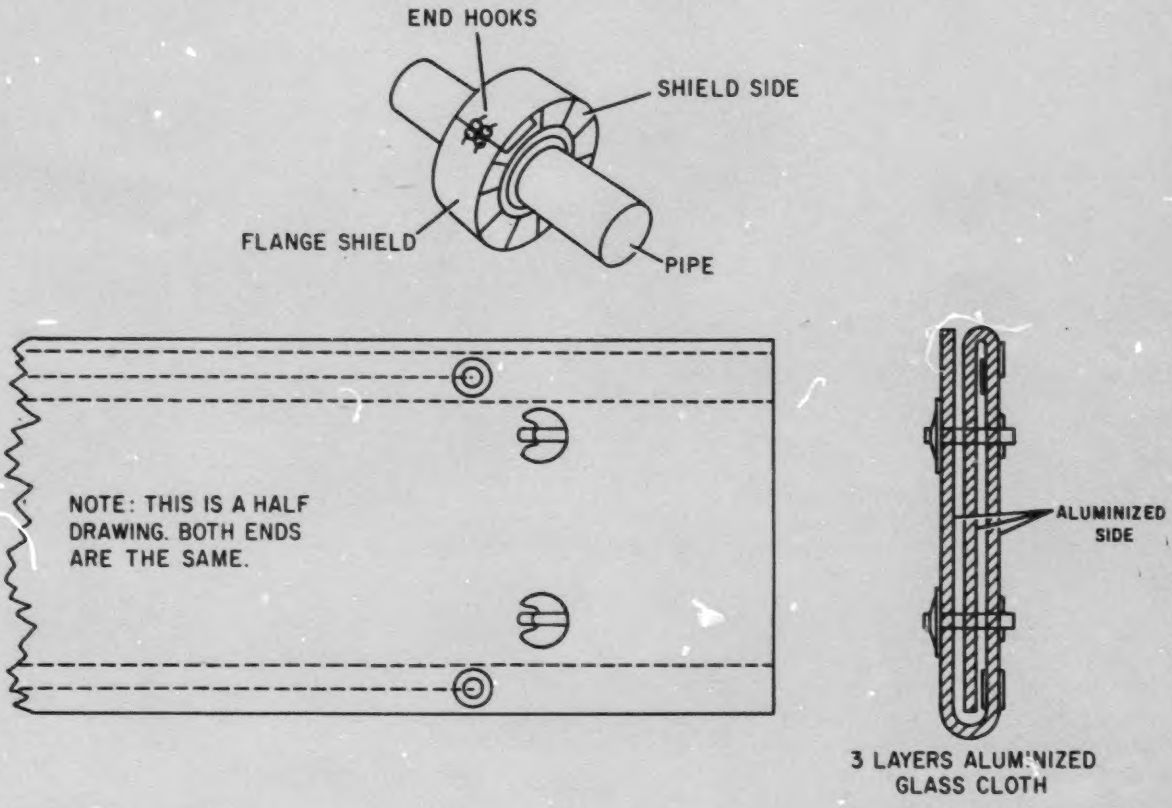
END HOOKS
SHIELD SIDE
FLANGE SHIELD
PIPE
NOTE: THIS IS A HALF DRAWING. BOTH ENDS ARE THE SAME.
ALUMINIZED SIDE
3 LAYERS ALUMINIZED GLASS CLOTH

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Figure 9-17.—Flange safety shield, (aluminized glass cloth).

limits by lightly tapping these areas with a ball-peen hammer. Then punch the boltholes, allowing sufficient clearance for the flange bolts, and trim the inner and outer edges of the gasket. Make sure that the inside diameter of the gasket is cut the same as the inside diameter of the pipe at the flange surface. (This procedure should be used only for MARKING the gasket; do not cut the gasket completely by this procedure.)

Another way to mark a gasket is to chalk the face of the flange. Then lay the gasket material over the flange and apply pressure to the material. This procedure will transfer the chalked impressions of the flange to the material.

Gaskets may also be cut with shears, snips, or a sharp knife. When using any of these tools, the material must be appropriately marked as previously described before cutting out the gasket.

Gasket cutters are provided to cut gaskets from sheets of gasket material such as cork, rubber, leather, and asbestos and fiber composition. One type of gasket cutter is illustrated in part A of figure 9-18. To use this cutter, place the gasket material on a wood surface and adjust the two cutters—one for the inside cut, the other for the outside cut. Place the shank in a brace and insert the center pin in the gasket material and rotate the brace, thereby forming the gasket. If the gasket is to have boltholes, they are punched out with a gasket punch of the type illustrated in part B of figure 9-18. These punches are available in various sizes. Punching the boltholes a bit larger than the bolts will eliminate a tendency toward

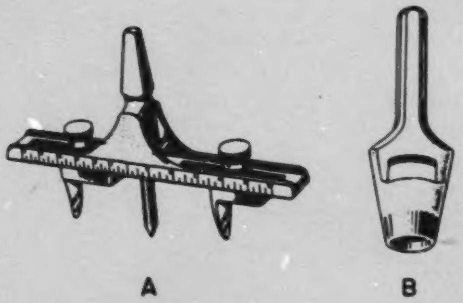

Figure 9-18.—Gasket cutter and gasket punch.

bulging along the bolt circumference. The center material should be cut so that the inside diameter is the same as the inside diameter of the pipe at the flange surface. On joints which require frequent breaking, one side of the gasket should be coated with graphite to lessen the danger of tearing the gasket when the joint is broken.

The procedure for making up a flanged joint is as follows. Two diametrically opposite bolts are set up fairly tight. A second pair of bolts is inserted at a distance of 90° around the flange from the first set, and tightened. The remaining bolts are handled in a similar manner. For final seating of the gasket, a feeler gage must be used at 90-degree intervals to measure gasket compression. Gaskets should be compressed between 20 and 30 percent of the original thickness. To prevent excessive side flow, permanent set, and/or loss of resiliency, the gasket must not be compressed beyond 70 percent of its original thickness.

NOTE: To facilitate measurement of gasket compression, four notches may be cut into the outside diameter of the gasket, at 90-degree intervals, and the original thickness of the gasket must be measured and recorded.

TEST JOINTS

Following gasket replacement, the joint must be tested for tightness. For this purpose, that portion of the system containing the joint should be isolated and pressurized slowly until the desired test pressure is reached.

When the replacement has been made at a shipyard or repair facility, the test medium should be nitrogen and R-12 tracer, using an electronic leak detector.

When joints have been made up by ship's force, and nitrogen and R-12 tracer are not available, the test may be performed either with air or JP-5.

NOTE: When using air, check the joint for leakage with a soap solution.

Test pressures to be used at the joint should not be greater than 135 percent of the JP-5 pump operating pressure.

DAMAGE CONTROL EQUIPMENT

During general quarters fuels repair team personnel are also stationed at the Repair 1 stations located on the hangar deck forward and aft and at the aviation fuels control station on the flight deck. If the ship receives damage, it is the responsibility of these men to make an immediate investigation of all aviation fuels fixtures in the area of the damage and take corrective measures.

If an enemy attack is imminent, all aviation fuel is drained from the fuel lines into the stowage tanks. All lines are then purged and charged with an inert gas. This will blanket explosive vapors in the fuel piping. Complete instructions for the operation of the aviation fuels systems and damage control features are discussed in chapters 5 and 6 of this training manual.

All doors, hatches, scuttles, accesses, and valves and fittings of damage control value are classified and marked. They are referred to collectively as damage control fittings. Each fitting is labeled as either a W, X, Y, or Z fitting or as a Circle W, X, Y, or Z fitting. During general quarters and readiness condition TWO, the hangar deck repair parties are responsible for setting and maintaining the authorized material condition of readiness for the hangar deck spaces. This is accomplished by closing the damage control fittings that are designated to be closed by the damage control bill for the particular material condition of readiness being set.

If, for any reason, a gasoline line inside the ship is ruptured when it is pressurized with fuel, the following procedure should be followed:

1. Immediately stop all pumps servicing the affected piping.
2. Isolate the affected piping by manipulating the appropriate valves.
3. Stop the flow of fuel from damaged piping.
4. Remove all personnel not wearing appropriate breathing apparatus from the space.
5. Stop all electrical machinery (even explosionproof motors unless required for vital ship's services) both in the space and in adjacent spaces through which air currents might pass from the space containing explosive vapor.

CAUTION: Operate remote switches to prevent the possibility of sparks. Take all possible precautions to prevent sparks from electrical or mechanical means.

6. Close and, if necessary, seal the space until effective exhaust ventilation is assured.
7. Drain and purge the affected piping until permanent repairs can be made.

If a fuel line outside of the ship is ruptured when pressurized with fuel, the procedure is essentially the same; however, the danger of explosive vapors is greatly minimized. The fuel vapors will be carried away before a dangerous mixture forms; however, extreme caution must be exercised in the immediate vicinity of the rupture.

If a fuel line that is charged with an inert gas is ruptured, it is repaired with a soft patch. It is then recharged. Before entering spaces in the vicinity of such ruptures, a test is made with the combustible gas indicator to determine the absence/presence of flammable gases. If flammable gases are present, the spaces are ventilated free of them before entering. Since the spaces may contain inert gas, the flame safety lamp is also used before entering to assure the presence of adequate oxygen to support life.

The aviation fuels repair team maintains sound-powered telephone communication at all times during general quarters on both the gasoline control circuit (4JG) and the damage control circuit (2JZ). Only the 4JG circuit is manned during flight quarters. Additional available means of communications are the ship's service telephone interstation two-way system (4 MC), general address system (1 MC), and messengers.

Personnel assigned to the fuels repair team during flight quarters are charged with the repair of aviation fuel system casualties resulting from operational breakdown. These men must be adept at machinery repair as well as damage control procedures. For further information on damage control features refer to Hull Maintenance Techncian 3 & 2, NAVEDTRA 10573 (Series).

EQUIPMENT COLOR CODES

Piping systems aboard ship are normally painted to match the surrounding compartment. The piping identification is made by labeling the pipe with the type of fluid flowing through it and an arrow for indicating the direction of flow.

In some piping systems, however, the valves, associated equipment, and in some instances, the pipelines are painted a specific color for identification purposes. A knowledge of this means of identification is essential in firefighting and damage control. Some of the colors are as follows:

1. Fireplugs (fire main system)–Red formula #40.
2. Foam Equipment (High Capacity Systems)–Foam tanks, proportioners, and pumping equipment–machinery gray. All piping and risers the same color as surrounding structure.
3. Monitors and Nozzles–Green formula #39 with one 2-inch band of red formula #40 around each nozzle or discharge device.
4. Hose Valves or Cut Out Valves in Foam Piping–Green formula #39, identify with one 2-inch band of red formula #40.

5. Carbon Dioxide (CO_2) Equipment—All CO_2 cylinders, both fixed and portable, together with release mechanisms and associated fittings except hose and nozzles—red formula #40.

6. Gasoline Piping and Valves—Yellow in interior spaces.

7. JP-5 Fuel Piping—Purple in interior spaces.

RECORDS, REPORTS, AND LOGS

The petty officer in charge of the fuels repair team should make sure that records, reports, and logs are kept in the manner designated and are correct and current. There are usually two kinds of logs—operational and maintenance.

In the operational logs, hours of operation of equipment should be recorded. This information will be very useful in keeping current the maintenance project cards of the ship. Any other operational data that could be useful at a future date should be recorded.

The maintenance logbook should contain all work performed to the aviation fuels systems by the repair team and should be recorded in a day-to-day order. The maintenance logbook should also be inspected frequently by appropriate petty officers and the division officer. All logbooks maintained in the repair team locker should be made in duplicate. The rough logs are kept in the repair team locker, and the smooth logs should be kept in the V-4 division office.

In addition to the normal records and logs, it is imperative that everyone understand and use the 3-M system as outlined in OPNAVINST 4790.4 Vol 1 and Vol 2.

Chapter 10

FUEL FARMS AND MOBILE REFUELERS

Fuel farms and fuel delivery operations ashore are the responsibilities of the supply department. The normal petroleum operations consist of the receipt, stowage, and issue of aviation petroleum products to the aircraft. These operations include the inspection and quality assurance of these fuels.

FUEL FARMS

The fuel farm of a naval air station is concerned with the stowage tanks, underground transfer system, the major pumping stations, and associated equipment. This part of the fuels division is normally operated and maintained by civilian personnel, though some military personnel may be assigned. Military personnel, when attached to the supply department, are usually assigned to the operation of the refueler equipment and to the actual delivery of aircraft fuels to the aircraft.

COLOR CODES OF PIPING

Identification of petroleum lines must be in accordance with the Military Standard MIL-STD-161, "Identification Methods for Bulk Petroleum Products Systems." Under no circumstances are colors other than yellow for warning and black and white for identification ever assigned to petroleum products. Lines for other than petroleum products are marked in accordance with MIL-STD-101-A.

Exact identification of petroleum products in each piping system is mandatory and is made by means of lettered titles stenciled on the pipe adjacent to the control valve. The stenciled title identifies the contents by nomenclature and symbol. Titles are lettered on the pipe in such a manner as to be clearly visible from operating positions. The use of stencils with standard size letters is recommended; but for piping smaller than 3 inches in diameter, metal flags or signs, securely fastened to the pipe, may be used.

In addition to the stenciled title, a standard method for identifying petroleum products in pipeline systems by means of color bands has been established. The purpose of this method of identification is to promote greater safety to personnel and to lessen the extent of error, confusion, and inaction in times of emergency. It is emphasized, however, that the exact title, stenciled on pipelines, is the principal identifying feature and that the color band or bands should not be relied upon as the sole means of identification. See figure 10-1 for the methods of marking petroleum pipelines.

MAIN STORAGE TANKS

These are the large tanks used for stowing several days' supply of fuel. Aircraft fuels are pumped into these tanks upon receipt from suppliers.

The type, number, and location of the main stowage tanks vary with the size, location, and mission of the air stations. These tanks are classified by the type of roof for surface (above ground) tanks and the type of material for subsurface (below ground) tanks. The roof may be of the floating, fixed, or expansion type.

The floating roof tank is used in tropical or temperate climates. The roof floats on the liquid level and moves up and down in accordance with the increase or decrease of the liquid level in the

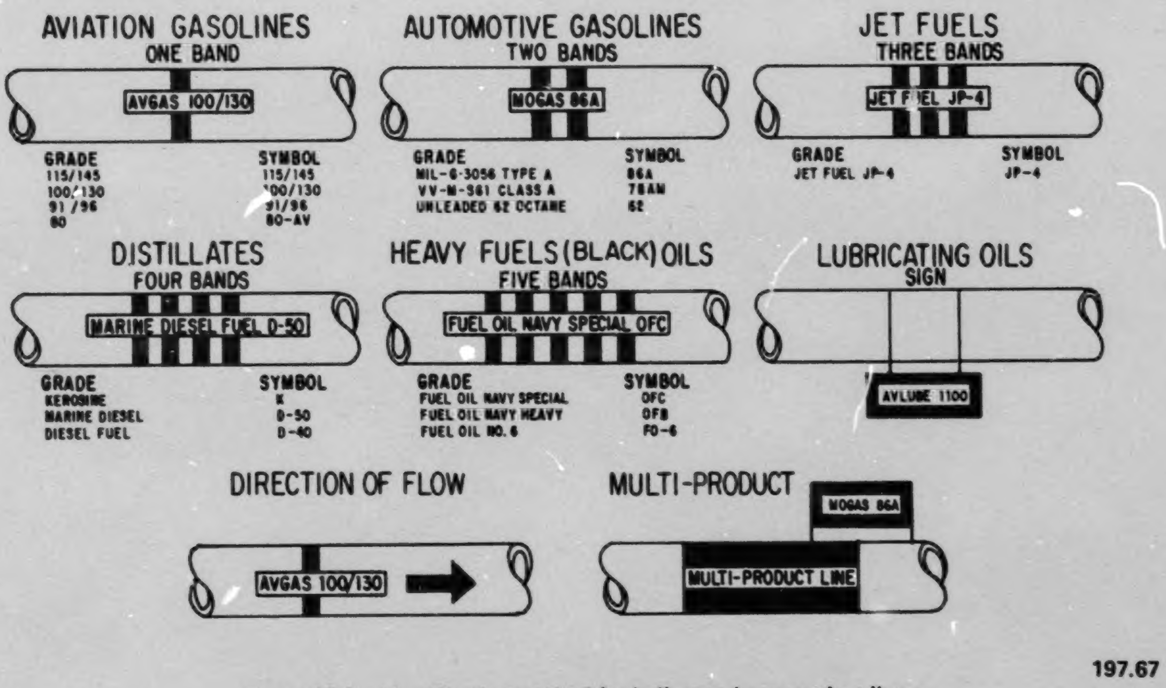
AVIATION GASOLINES
ONE BAND
AVGAS 100/130
GRADE
115/145
100/130
91/96
80
SYMBOL
115/145
100/130
91/96
80-AV
AUTOMOTIVE GASOLINES
TWO BANDS
MOGAS 86A
GRADE
MIL-G-3056 TYPE A
VV-M-561 CLASS A
UNLEADED 62 OCTANE
SYMBOL
86A
78AN
62
JET FUELS
THREE BANDS
JET FUEL JP-4
GRADE
JET FUEL JP-4
SYMBOL
JP-4
DISTILLATES
FOUR BANDS
MARINE DIESEL FUEL D-50
GRADE
KEROSINE
MARINE DIESEL
DIESEL FUEL
SYMBOL
K
D-50
D-40
HEAVY FUELS (BLACK) OILS
FIVE BANDS
FUEL OIL NAVY SPECIAL OFC
GRADE
FUEL OIL NAVY SPECIAL
FUEL OIL NAVY HEAVY
FUEL OIL NO. 6
SYMBOL
OFC
OFB
FO-6
LUBRICATING OILS
SIGN
AVLUBE 1100
DIRECTION OF FLOW
AVGAS 100/130
MULTI-PRODUCT
MOGAS 86A
MULTI-PRODUCT LINE

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Figure 10-1.—Identification method for bulk petroleum product lines.

tank during filling and emptying operations. This reduces vapor losses due to breathing caused by daily temperature changes, thereby reducing the fire hazard from vapor and air mixtures. The expansion roof type is used in more northern climates, as snow does not affect the tank roof as it does the floating roof type of tank.

The expansion roof is designed to prevent evaporation loss by providing an expansible vapor space which retains the air-vapor mixture above the stored fuel. This air-vapor mixture is allowed to expand or contract within certain limits of vacuum or pressure. The roof consists of an ordinary cone roof of slightly larger diameter than the tank. The roof rises and falls above the shell of the tank on downward projecting guides attached to the roof. A seal is provided to make the roof tight. A vacuum breaker valve is installed to relieve any vacuum that might damage the tank. A pressure relief valve is installed to relieve any overpressure. The pressure in the tank, when the roof is lifted, is due to the weight of the roof. The pressure relief and the vacuum breaker valves may be combined into one valve housing.

The formation of vapors in subsurface tanks is limited due to the constant temperature of the earth that surrounds them. Subsurface tanks for the stowage of gasoline or jet fuel are designed to withstand a slight internal pressure and a slight vacuum, depending on the design specifications for the particular tank. Vents for tanks designed to store jet fuel or aviation gasoline must be provided with a flame arrester.

Navy aircraft fuels stowage facilities make considerable use of subsurface stowage tanks; for example, all the fuel at El Centro is stored in this manner. Other stations, such as Oceana, use a combination of surface and subsurface stowage. Some stations using the surface and subsurface combination cover the part of the tank that normally protrudes above the ground line with a mound of earth, thereby achieving some of the advantages of subsurface stowage such as less condensation, less vulnerability to damage, etc.

READY SERVICE TANKS

Fuel is pumped from the main stowage tanks to the ready service tank. At some stations these tanks are referred to as "day tanks," because they were originally designed to hold approximately the amount of fuel required for a day's operation. Not all stations are equipped with such tanks, for the design features of some systems are such that they are not needed in accomplishing the mission at that particular station. These tanks also contain a sump or stripper pump for the removal of bottom water and/or residue.

When provided, the day tank is usually a vertical steel subsurface tank. A number of deep-well fuel transfer pumps are installed through the roof of this tank. Factors which have a bearing on the number and capacity of the transfer pumps used are the size of the tank, operating pressure of the system, number of fueling stations serviced, etc.

TRUCK FILLING STANDS

A truck filling facility consists of a row of loading stands, each accommodating one truck on each side. (See fig. 10-2.) There is a separate filling stand for each type of fuel to be issued. The total number of stands depends on the size of the air station. The equipment necessary for the delivery of fuel to each truck is mounted on each stand. This equipment consists of the piping, manifolds, surge suppressors, filter/separators, fuel quality monitor, static charge reducer (relaxation chamber) for the dissipation of static electricity, meter, and dead man controls.

Remote controls for starting and stopping the delivery pumps are located on one end of the island.

All materials downstream from and including the filter/separator should be nonferrous or stainless steel materials. The construction of top-loading fill stands has been discontinued. Newly installed fill stands are of the bottom-loading type. Bottom loading of refuelers affords the following advantages:

1. Safety–The most dangerous of fuel handling operations is the loading of fuel trucks at fill stands employing the top-loading method.
2. Quality control–Because the bottom-loading method is a closed system, there

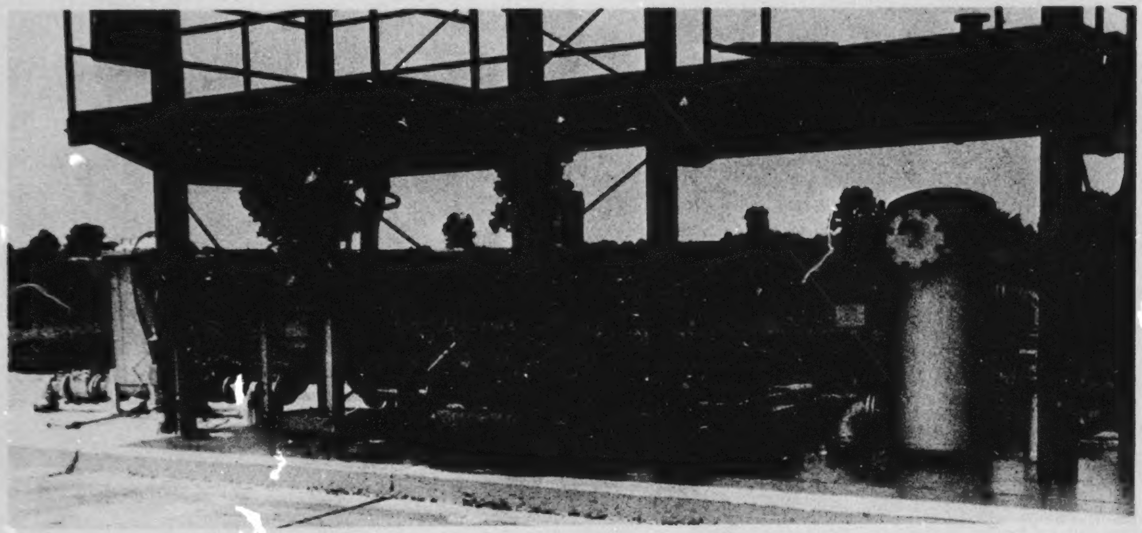

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Figure 10-2.–A typical truck filling stand.

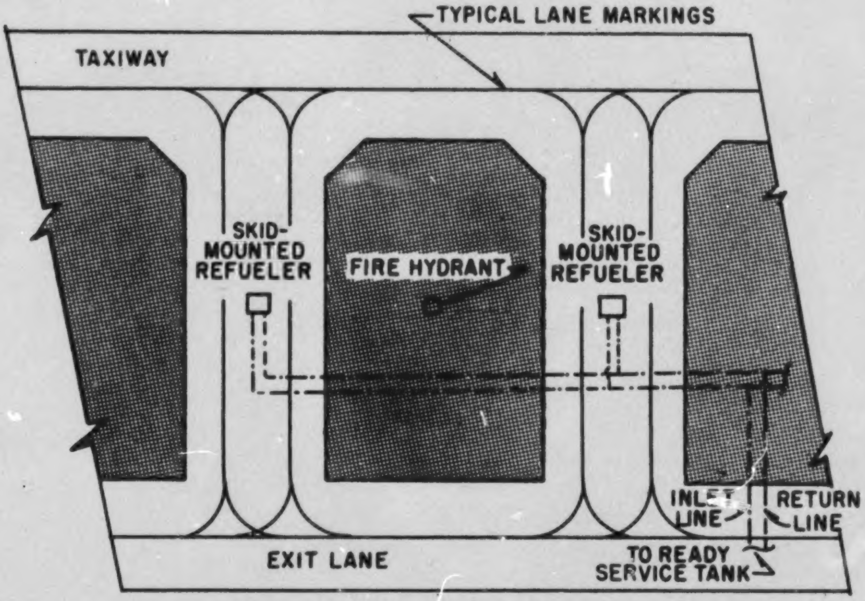

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Figure 10-3.—Typical refueling stations.

is less chance of the fuel becoming contaminated.

3. Manpower utilization–If the fill stand incorporates a dead-man type of control, one person may perform the truck loading.

REFUELING STATIONS

The refueling stations or islands (fig. 10-3) are located just off the air station taxi strips so that aircraft returning from a flight may taxi directly up to the refueler before returning to the flight line or to the runway for another flight.

The refueling lanes are located so that aircraft may be conveniently towed from the flight line to the fueling station. Refueling lanes are designed for handling two aircraft at a time, one on each side of the skid-mounted refueler. These units are classified as fixed equipment rather than mobile or movable equipment. Such units are found on about 10 naval air stations and are used extensively on master jet bases.

Each refueling station consists of one or more skid-mounted refuelers, an auxiliary powerplant, and other equipment necessary for accomplishing the refueling operation such as grounding wires, hoses, adapters, movable stands, firefighting equipment, lighting equipment, etc.

SKID-MOUNTED REFUELER

A skid-mounted refueler (fig. 10-4) is a steel framework forming a skid on which is mounted filtering, metering, and dispensing equipment.

This particular refueler will deliver fuel at the rate of 400 gallons per minute. It is provided with fittings so that it may be connected to the fuel supply hydrant and the fuel return hydrant. Normally, it is not necessary for refueling personnel to make any connections between the refueler and the hydrants, as these connections are made and left in place.

The fuel leaving the hydrant flows through a strainer and a filter/separator. (Filter/separators

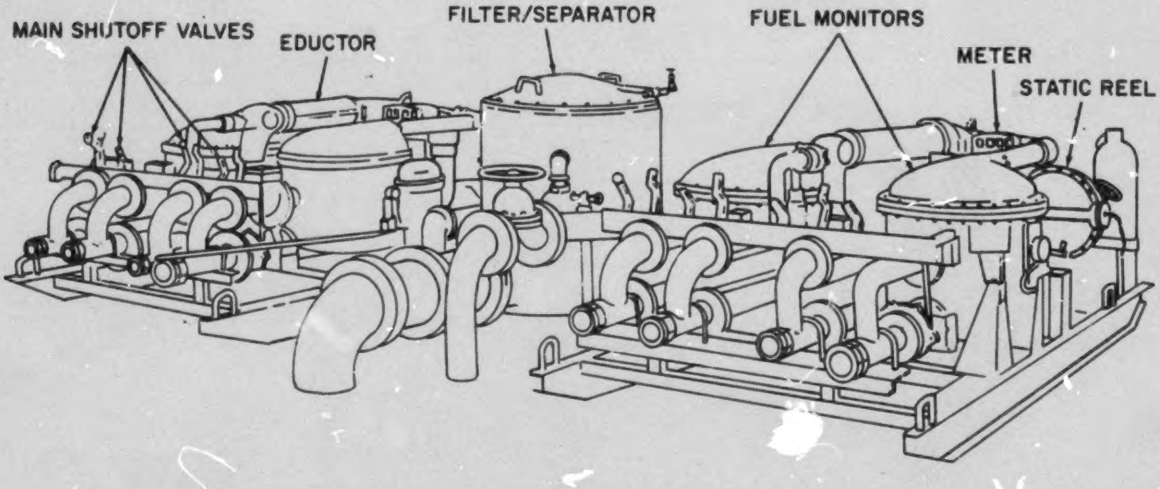

Figure 10-4.—Skid mounted refueler.

are also located at the ready service tanks to remove any water from the fuel before it enters the hydrant.) From the filter separator, the fuel flows through a fuel quality monitor of the appropriate size.

The fuel quality monitor provides a continuous check on the cleanliness of the fuel passing through the filter/separator. Fuel that meets a predetermined standard of cleanliness passes through the monitor with a minimum of pressure drop. Fuel flow containing quantities of solids and/or water above the predetermined acceptable level is automatically cut off.

Fuel from the fuel quality monitor flows to the meter on the skid-mounted refueler, through the main shutoff valves, and to the hoses and nozzles. An eductor is installed to evacuate the hose upon completion of fueling the aircraft.

FUELING PROCEDURES

The general procedures used in the refueling of aircraft at refueling stations are basically the same for all naval air facilities so equipped. Detailed refueling procedures are normally published in locally prepared instructions or aircraft fuels manuals, along with associated safety procedures to be followed.

The basic steps to be taken prior to the day's operations are as follows:

1. Ascertain that the ready service tank is manned and ready for operation.
2. Pressurize the system and check it for proper pressure and for leaks in all associated equipment, hoses, nozzles, etc. Correct any discrepancies noted and/or report them to the proper authorities.
3. Complete daily inspections, using the forms provided for this purpose.

The operating procedures for the refueling of aircraft at the refueling station are as follows:

1. All aircraft must be stopped on, or before reaching, the safety line before proceeding to the refueler. While stopped, the aircraft should be checked for hot brakes and the pins or downlocks installed in the landing gear.
2. Aircraft awaiting fuel must remain at the safety line well astern of any aircraft that is being fueled.
3. The maximum number of aircraft permitted to a high-speed refueler is one for

single-lane fueling stations and two for double-lane stations.

4. All electrical grounds and hose connections must be made in the proper order. The grounds must be made to an unpainted surface of the aircraft. The proper sequence for making the grounds and hose connections are as follows:

a. Attach main ground cable from the high-speed refueler to the aircraft.

b. Attach nozzle ground cable.

c. Attach nozzle to the aircraft.

d. Connect electrical power to the aircraft and perform fueling precheck on aircraft in accordance with squadron doctrine.

CAUTION: Do not refuel if aircraft fueling precheck is not satisfactory according to squadron doctrine.

e. When the fueling of the aircraft is completed, disconnect the above items in reverse order.

SAFETY PRECAUTIONS

As with the operating procedures the safety precautions applicable to refueling lanes differ from station to station to fit local conditions. Some of the basic safety precautions applicable to refueling lanes in general are as follows:

1. Lighted cigarettes, matches, flames, or unnecessary electrical equipment must not be allowed within 100 feet of the refueling lane. All electrical gear and internal combustion engines not directly used in the fueling operation must be secured.

2. There must be no maintenance, arming, dearming, or other servicing of the aircraft while it is being fueled.

3. Personnel must be in full uniform at all times. Uniforms should be made of material that does not generate static electricity. Shirt sleeves must be down and buttoned at all times. Fuel-soaked clothing must be removed as soon as possible and any affected part of the body washed with soap and water.

4. Tools and metal objects must be stowed in their respective compartments when not being used. Only nonsparking tools should be allowed in the refueling lane area.

5. Fuel nozzles must be shut off promptly and fueling operations stopped in cases where a fuel spill occurs or there is a breakdown of the fueling equipment. Fueling operations should not recommence until a washdown has been made and the cause of the spill or breakdown has been determined and corrected.

6. Either a twinned agent unit (TAU) with light water and purple-K-powder or a portable dry chemical fire extinguisher must be readily accessible for use on wheel fires and fuel fires when the refueling lanes are in operation. Water and CO_2 must not be used on wheel fires.

7. A BRAVO flag must be flown during daylight hours, and dustpan lights must be lit at night in each refueling lane whenever the lane is open and ready to issue fuel or is issuing fuel.

The following additional safety precautions must be used during "hot refueling" (Aircraft engines idling).

1. If the aircraft has hot brakes, the pilot should taxi the aircraft away from the fueling area.

2. A fire truck and operating personnel must be available during all fueling operations.

3. Sound attenuating ear protectors must be worn at all times by personnel in the fueling pits when aircraft engines are idling.

4. Refueling hoses must be positioned during refueling so as not to interfere with the rapid exit of the aircraft from the pit.

MOBILE REFUELERS

The mobile refuelers used aboard naval air stations vary in type and capacity. There are three refuelers in use at the present time: a 3,000-gallon capacity truck-chassis-mounted refueler, a 5,000-gallon semitrailer-mounted refueler, and a 5,000-gallon truck-chassis-mounted refueler. The refueler discussed first is the 5,000-gallon truck-chassis-mounted refueler. This refueler is designated the RF-50.

RF-50 MOBILE AIRCRAFT REFUELER

The refueler (fig. 10-5) consists of a 5,000-gallon capacity, one-compartment tank, mounted on a commercial truck. It is designed for refueling aircraft by means of a power-takeoff-driven pumping system. The pumping system is composed of a pump, a filter/separator, a fuel meter, a fuel quality monitor, hoses, discharge nozzles, and the required controls for fueling operations. Fuel can be pumped from the discharge hoses into the aircraft or from the aircraft back into the refueler (non-suspect fuel only) for defueling purposes.

Description and Operation

Operating procedures of the refueler require the constant attention of a three-man crew. One member (operator/driver) is responsible for proper location, grounding, and operation of the fueler, while another member (the plane captain or some other member of the flight line crew) completes the actual fueling hookup to the aircraft. A third man serves as fire watch and devotes his full attention to the duties of that watch.

After stopping the refueler, putting the transmission in neutral, and setting the handbrake, connect one end of the static reel ground wire to a ground post and the other end to the aircraft. This provides an electrical bond for both refueler and aircraft to ground.

The balanced emergency valve is manually opened by pulling the overcenter lever located by the cabinet instrument panel. It can be closed by spring action by reversing this motion. Further, the emergency valve can be trip-closed remotely by pulling on the emergency trip located at the rear of the refueler on the rear tank crossmember. The emergency valve operator is also fitted with a fusible link having a low melting point which causes the emergency valve to shut when exposed to excess heat from a fire.

Open the valve to the hose reel to be used and pull out the hose manually. The hose reels are top wound with a drag brake and contain a hose snubber to automatically stop the hose when it is fully unwound. A waterproof electric deadman switch is attached to each for rewind operation. The hose reels are rewound by electric explosion-proof radio-noise suppressed motors.

Connect the hose to the aircraft and open the nozzle.

Depress the power takeoff (PTO) engage switch. Keep the switch depressed until the red

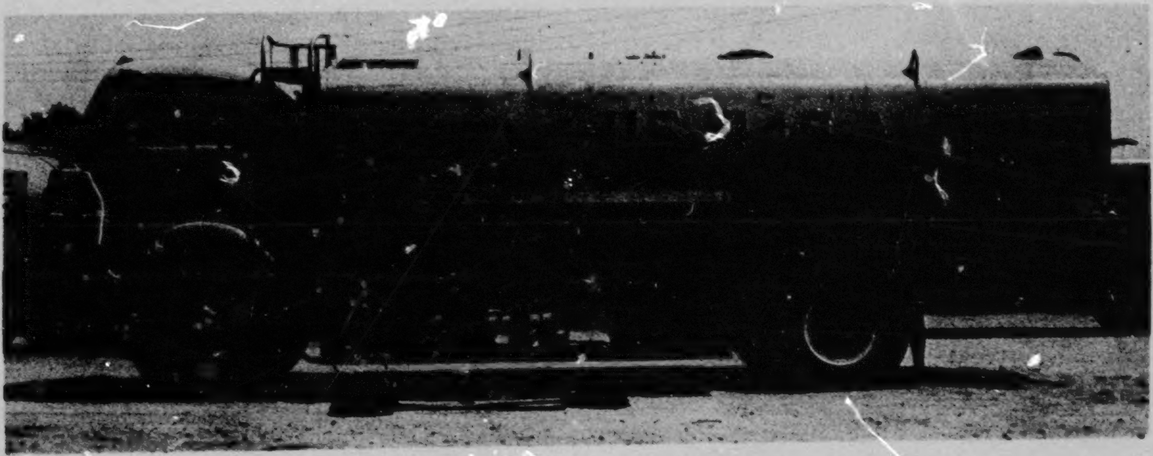

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Figure 10-5.—RF-50 mobile aircraft refueler.

light is lit. Depressing and holding the engage switch actuates the PTO shifter lever and supplies air to the service brakes on the rear wheels. When the PTO is engaged, it lights the red light on the truck instrument panel and on the cabinet control panel. A disengage switch is provided to release the PTO and the rear brakes.

The pump should normally be operated at 1650 rpm to obtain a flow of 200 gpm through the single point system with a 45-psi nozzle pressure. To obtain the optimum throttle setting, advance the throttle until a filter/separator outlet pressure reading of 105 psi is obtained, then depress the deadman valve to start the flow. The throttle should then be readjusted until the maximum filter/separator outlet pressure is reached. This pressure is determined by the bypass valve setting which will limit the maximum rpm of the pump when the flow to the aircraft is stopped. When servicing through the overwing system only, it is not necessary to operate the pump at peak rpm. In this case, the filter/separator outlet pressure should be set at 80 psi, before depressing the deadman valve. Operated in this manner, the main valve provides a constant pressure of approximately 45 psi to the overwing hose reel inlet.

The refueling operation can be stopped at any time by releasing the deadman valve.

To evacuate the 2 1/2-inch collapsible hose after fueling with the single point nozzle, the throttle control should be adjusted to give an engine speed of 650 rpm. The single point nozzle should be closed. Check that the valve to the overwing nozzle hose reel is closed. Pull out and hold the remote linkage to the eductor discharge valve. When the hose is flat, release the eductor valve handle and close the valve to the single point hose reel. CAUTION: Continued application of a vacuum to a hose will cause damage to the hose. Adjust the throttle control to engine idle speed and, with the engine idling, depress the PTO disengage switch and hold it until the green light is lit. Close the tank emergency valve, roll up the hose, and store the nozzle.

This truck has a bottom-loading feature. By making use of selective fuel adapters on the nozzles and truck, this feature prevents the inadvertent loading of the wrong fuel into the truck. It also minimizes the turbulence and the resulting generation of static electricity.

To fill the truck the following procedures are used. With the truck parked in the fill stand, set the parking brake and place the transmission in neutral. Leave the tank emergency valve closed. Ensure the truck's air pressure is at the maximum of 90 psi before attaching to the bottom-loading system.

After attachment of the single point nozzle, the fill stand providing the fuel should be pressurized and the pressure indicated by the pressure gage noted. Precheck the refueler prior to starting fuel flow by use of the established precheck procedures for the particular refueler being used. The manual valve can then be opened to start flow into the tank. The filling is continued according to the established procedures for the particular refueler being used.

MODEL 2246 MOBILE AIRCRAFT REFUELER

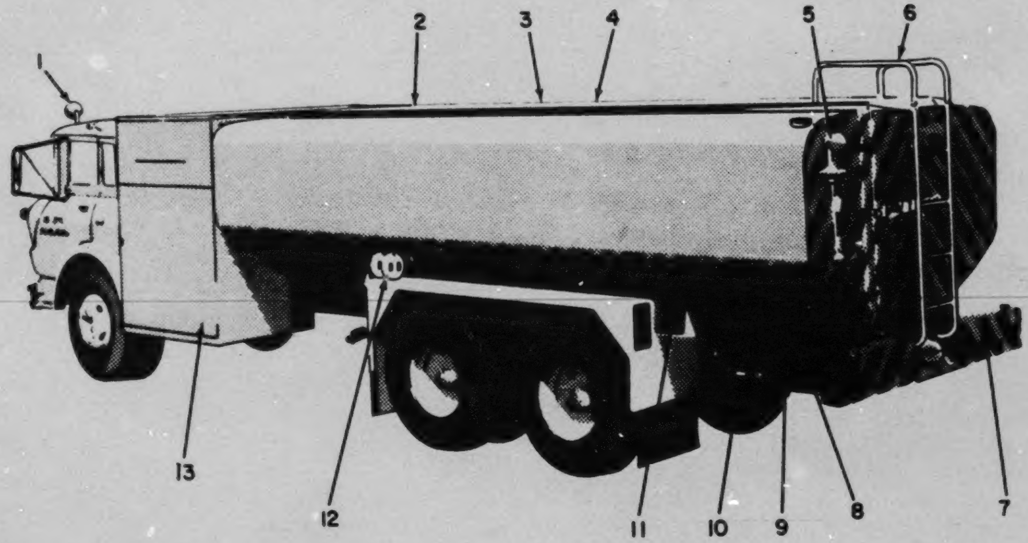
Description:

The model 2246 refueler is comprised of a modified General Motors 6 x 4 tilt-cab chassis on which is mounted a 5,000-gallon tank and a completely enclosed compartment containing the pumping and fuel servicing equipment. It is capable of refueling at a rate of 600 gpm and defueling at a rate of 200 gpm. It can achieve a road speed in excess of 35 mph fully loaded.

The basic truck shown in figure 10-6 is driven by a 478-cubic-inch displacement V-6 gasoline engine. It is equipped with automatic transmission, power steering, and full air brakes. There is a power takeoff from the truck engine to drive the pumping system.

Components:

TANK.–The tank is a one-compartment unit constructed of sheet aluminum alloy. It has a capacity of 5,000 gallons plus an additional three-percent expansion space. A sump located at the lowest point of the tank is provided to collect solid contaminants and water. There is a drain valve in the sump to permit removal of



1. Spotlight.
2. Catwalk.
3. Clean-out stubs.
4. Tank vent system and manhole.
5. Spotlight.
6. Boarding ladder.
7. Running light.
8. Manual shutoff valve.
9. Cylinder-operated shutoff valve.
10. Bottom loading inlet manifold.
11. Bottom loading control panel.
12. Static ground reel.
13. Pumping system housing assembly.

197.94

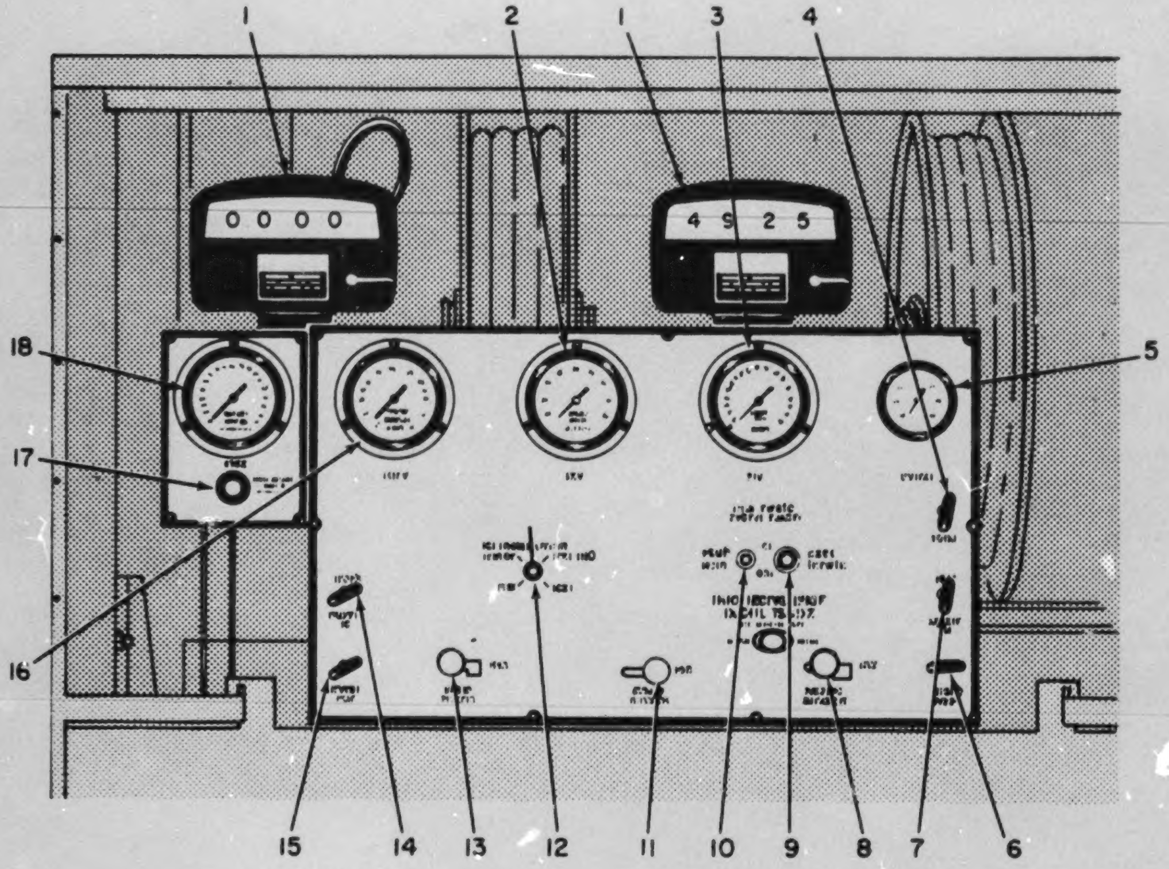
Figure 10-6.—Model 2246 aircraft refueling tank truck.

these contaminants. The tank is baffled in accordance with ICC regulations. A boarding ladder at the rear of the tank provides access to the catwalk along the top of the tank. The tank vent system and a manhole, with a quickly removable cover, are located on the top of the tank. In addition, clean-out stubs are provided for steam cleaning the interior of the tank.

HOUSING ASSEMBLY.—The pumping system housing assembly is located between the tank and the truck cab. It houses the main base to which are mounted the various components. Doors on the left side of the housing give access to the hoses and the hose reels, meters, and control panel. The access door on the right side of the housing provides access to the filter-separator, fuel quality monitor, pumping system automatic control valves, and other components of the system. The roof is held by quick release latches and provides access to the top of the filter-separator. A removable panel in the front of the housing provides access to other control elements.

MAIN BASE ASSEMBLY.—The main base assembly is the structure to which the filter-separator, service hose reels, meters, control panel, and various plumbing components are mounted. It is completely enclosed by the housing and mounted across the truck chassis, between the tank and the cab.

CONTROL PANEL.—The control panel is located inside the plumbing system housing assembly, (see fig. 10-7) on the lower left side. It contains controls, switches, and instruments necessary for the operation of the refueler.



1. Meters.
2. Filter separator differential pressure gage.
3. Pump discharge pressure gage.
4. Engine auxiliary throttle control.
5. Engine tachometer.
6. 2-inch hose reel rewind control.
7. 2-inch hose reel brake control.
8. 2-inch hose reel valve V30A-2 control.
9. Engine emergency shutdown switch.
10. Compartment lights switch.
11. Tank vent valve V02B control.
12. Selector valve.
13. 3-inch hose reel valve V30B-2 control.
14. 3-inch hose reel brake control.
15. 3-inch hose reel rewind control.
16. Nozzle pressure gage.
17. Gage pressure selector.
18. Fuel quality monitor pressure gage.

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Figure 10-7.–Main control panel.

PUMP AND POWER TAKEOFF UNIT.–The pump and power takeoff unit is bolted to the frame of the truck chassis, directly beneath the front of the tank. The pump, which is a part of the power takeoff unit, is a self-priming centrifugal type. It is connected to the tank by a suction line which ensures that the pump inlet is flooded at all times, as long as the tank contains fuel. The power takeoff unit is a split-shaft type; that is, the power takeoff unit splits the drive shaft of the truck at a point between the truck transmission and the rear axle differential gear housing. The power takeoff unit is connected to the engine drive shaft. A sliding gear type of clutch unit permits driving either the pump or the rear axles from the engine. A transmission brake is provided to stop drive shaft drift when the power takeoff is being shifted. A parking brake is also provided on the axle drive shaft to lock the rear wheels, thereby preventing the truck from rolling when parked.

FILTER-SEPARATOR.–The filter-separator traps and separates water, dirt, rust, sand and other impurities from the fuel stream. The filter-separator consists of a vertical, cylindrically-shaped tank which houses the filter elements. A removable cover provides access for replacement of the elements and cleaning the assembly. A float control, located inside the filter-separator sump, opens an automatic water drain valve at the bottom of the filter-separator when an excessive amount of water is accumulated in the sump. A manually-operated, filter-drain valve, located at the bottom of the filter-separator, is used to sample the sump contents and drain the filter-separator before changing the elements. A differential pressure gage on the control panel indicates the relative cleanliness of the filter-separator elements. It measures the difference between the fuel pressure on the input side and the output side of the filter-separator.

SERVICE HOSES.–There are two service hoses installed on reels mounted on the main base behind the meters. The left-hand reel, when facing the control panel, mounts 60 feet of three-inch hose, and the right reel mounts 60 feet of one and one half-inch hose. The hoses may be rewound independently or simultaneously by actuating one or both of the switches mounted on the control panel. When a switch is actuated, a motor coupled through a drive turns the applicable reel. Each reel is provided with a brake which prevents the hoses from unwinding when they are not being used. The brake also prevents the hose reels from overrunning when the hoses are being rewound. The brake is operated by a brake control which is mounted on the control panel. Each hose must be fully unwound from its reel to open a mechanically-interlocked valve which prevents fuel flow to the nozzles.

FUEL QUALITY MONITOR.–The fuel quality monitor is located downstream of the filter-separator. It serves to sense fuel contamination and, if evident, reduces fuel flow to a noticeably low level. The monitor consists of a vertical cylindrically shaped tank which houses twenty fuse elements. A removable cover provides access for replacement of the fuses and for cleaning the housing. A pressure gage on the control panel indicates the relative cleanliness of the fuses. It measures the fuel pressure at the inlet and outlet ports of the monitor as a function of a manually operated valve. The difference in pressure readings is used as the criteria for replacement of the fuses.

METERS.–Two meters are mounted on the main base. They measure, in gallons, the amount of fuel flow during all operations. A maximum of 9,999 U.S. gallons may be registered on each meter. A reset knob is provided to return the reading to zero, as required. The totalizer on each meter records the total number of gallons up to 9,999,999. It cannot be reset.

MAIN TANK SHUTOFF VALVE.–The main tank shutoff valve is a manually operated butterfly valve in the suction line between the tank and the pump. When closed, all fuel flow from the tank is stopped.

MAIN BYPASS VALVE.–The main bypass is a diaphragm-operated valve located at the inlet side of the filter-separator. It opens or closes depending on the fuel pressure on its diaphragm. This pressure is controlled by a series of pilot valves. When any of these pilot valves open, pressure on the diaphragm of the bypass valve is relieved, thus opening it and permitting fuel to bypass to the tank. In this manner, pressures and flow rates through the system are held to desired limits.

DEFUEL STUB VALVE.–This is a manually operated butterfly valve located downstream of the main tank shutoff valve in the suction line to the pump. It is closed at all times except in the defueling mode of operation. In defueling, the main tank shutoff valve is closed, and the defuel stub valve is opened.

MAIN SHUTOFF VALVE.–The main shutoff valve is a normally open, pilot-operated check valve located between the outlet of the filter-separator and the venturi. System pressure on its pilot closes it. Pilot pressure is controlled by a series of pilot valves. Through the action of its pilot valves, the main shutoff valve prevents water from entering the fuel system downstream of the filter-separator; controls flowrate during low-flow refueling; diverts flow for hose evacuation; blocks flow past it when the tank vent is closed; and limits flow through the meters to a safe rate.

VENTURI.–The venturi is located between the outlet of the mainshutoff valve and the tee to the inlet side of the meters. It is a small diameter cylinder with a flared tube connected to each end, and acts as a pressure sensing device.

EDUCTOR.–The eductor is a device designed to create a suction. It is used to draw fuel from the hoses during hose evacuation operations.

EDUCTOR CONTROL VALVE.–The eductor control valve is a pilot-operated valve which opens to provide a fuel return path to the tank during hose evacuation operations.

SELECTOR VALVE.–The selector valve is a five-position, manually-operated valve located on the control panel. The selector valve positions the automatic control valves for the various modes of operation.

DEFUEL CONTROL VALVE.–The defuel control valve is a pilot-operated valve which opens to permit fuel through the two-inch fuel meter to the tank during defueling operations.

HOSE REEL INTERLOCK VALVES.–A hose reel interlock valve is mechanically interlocked with each of the two hose reels. Each valve opens when the applicable hose is fully unwound from the reel.

HOSE REEL CONTROL VALVES.–A manually controlled hose reel control valve is adjacent to each of the two hose interlock valves.

HOSE REEL VALVES.–Each of the two hose reel valves is cylinder-operated. When each hose is fully unwound from its reel, the hose interlock valve opens. When the manually operated hose reel control valve is opened, air under pressure actuates the cylinder to open the hose reel valve. This sequence of events is designed to prevent inadvertent pressurization of the hoses in the wound position.

BOTTOM LOADING SYSTEM INSTALLATION.–The bottom loading system provides for loading the refueler's tank from the bottom. The system is pneumatically powered by the truck air brake system. It consists of an inlet manifold which incorporates a manually operated shutoff valve, a cylinder-operated shutoff valve and a self-sealing inlet receptacle and adapter; a series of valves; and a control panel. The entire system, with the exception of a float-operated valve and a vent interlock valve, is located at the lower left rear section of the tank. The inlet manifold enters the tank at this point. The float-operated valve is located inside the tank adjacent to the manhole. The vent interlock valve is located on the top of the tank adjacent to the vent.

BOTTOM LOADING CONTROL PANEL.–The bottom loading control panel contains four controls for operating the bottom loading system. This panel includes the tank vent control, the loading valve control, the pretest valve control, and the override valve control.

DEFUEL KIT.—An optional defuel kit consisting of an enclosed housing contains a mounted hose reel assembly on which is wound 50 feet of two and one-half inch diameter hose. The hose is fitted with a single-point nozzle and a coupling-strainer assembly equipped with a vacuum breaker. The hose is unwound from the reel by pulling and is rewound with a handcrank through a gearbox drive to the reel. Two doors provide access to the hose and reel. The entire unit is mounted on the left chassis rail of the truck and is connected directly to the defuel stub of the tank which is not installed on all refuelers.

Safety Devices

A number of safety devices are incorporated in the refueler for the protection of both the refueler and its operating personnel. These safety devices are as follows:

1. Two fire extinguishers are mounted on the truck chassis; one on the left-hand side between the plumbing installation housing and the rear wheels of the truck and one on the rear, right-hand side of the truck. Both units are held in place by locking lever clamps which may be snapped open for quick removal of the extinguishers. The extinguishers are portable and hand-operated.

2. Two static cable reels (12) are installed on the top front end of the left rear fender. The cable reels provide a means of grounding the aircraft and the truck during fueling and defueling operations.

3. Two fusible plugs are installed in the manhole cover. If the fuel becomes excessively hot, the plug melts, allowing fuel vapors to escape.

4. An engine emergency switch on the control panel. This is used to stop the engine in case of an emergency.

5. Bonded metal parts to prevent sparking.

6. Spark arrestor muffler.

FUELING AND DEFUELING PROCEDURES

One man is required for the proper and safe operation of the refueler when servicing an aircraft. This does not include the plane captain and fire watch who are usually squadron or other flight line personnel. The refueler driver is responsible for the proper positioning of the refueler, grounding, and operation of fueling controls on the refueler. The importance of making the proper approach to the aircraft with refuelers to avoid damage to the aircraft and equipment in case of brake failure, etc, cannot be overemphasized. For similar reasons and the possibility of fire, the actual position of the refueler during fueling operations is important.

The plane captain of the aircraft being refueled connects the fueling nozzle to the fueling point being used unless modified for particular air stations. An additional man should serve as fire watch, standing by with the approved firefighting equipment provided for this purpose.

The refueler driver ensures that water separators or sumps on aviation fuel truck tanks are drained at least once daily, or more often if indications of contamination are found to be present. If such is the case, all trucks are suspected and must be given additional drain checks.

The refueler driver must be certain that the aircraft is properly located away from all possible sources of ignition. If not, refueling MUST BE DELAYED until the aircraft is moved or the ignition sources eliminated.

The refueler driver must park the refueler as far from the aircraft to be filled as the hose will permit. It should be parked in a position so that it may be quickly driven away in the event of a fire. This means that the refueler should be parked parallel to or headed away from the wing. There must be no obstructions in front of the refueler to prevent its being driven away in an emergency.

After parking the refueler, set the handbrake and turn off the lights and any other electrical equipment.

The driver and the plane captain must make certain that the fuel in the refueler is the grade and type required for the aircraft.

The positioning of defueling trucks is the same as for refueling trucks.

Defueling and draining operations present greater fire hazards, and all safeguards must be adhered to. Aircraft may usually be defueled in all areas where fueling is permitted, but the clear areas surrounding the defueling operation must be a minimum of 100 feet.

The defueling of aircraft usually involves the transfer of large quantities of aviation fuel from the cells within an aircraft to a tank. Subsequent to these defueling procedures, small quantities of fuel are occasionally found remaining in the fuel systems of aircraft that have been drained.

When withdrawing these small residual quantities of aviation fuel, every effort must be made to collect such fuel in standard safety cans. If collection in a safety can is impossible, by reason of the structure of the aircraft and location of the drainage plug, the residual aviation fuel collected by any other means must be immediately transferred to a safety can properly marked to identify its contents.

SAFETY PRECAUTIONS

Fuel trucks must be in proper mechanical condition at all times. Preventive maintenance should be performed as scheduled by the public works department. If any discrepancies develop in the motor vehicle or its fuel delivery system which interfere with safe operation, the truck must be returned to the public works department for immediate repair.

To ensure the removal of water from fuel trucks used in fueling aircraft, all filter/separators must be checked daily in conformance with current NAVAIR Instructions.

A minimum distance of 30 feet must be maintained between parked fuel trucks and between parked or issuing trucks and any building.

The maximum speed limits for refueling trucks are as follows:

1. On station roads, 15 miles per hour, or as specified.
2. In fire lanes, 10 miles per hour.
3. In aircraft parking areas, 5 miles per hour.
4. On public highways, 35 miles per hour, or as specified.

Prior to crossing a taxi strip, a complete stop must be made until the driver is certain that aircraft are not moving in the immediate area.

Runway crossings must be made as directed from the tower.

Position of aircraft to be refueled should be located on the apron so as to provide for unobstructed entrance and exit for the refueler.

Welding operations or repair work involving electrically operated tools is not permitted within 100 feet of fueling operations. Aircraft must not be started, operated, or taxied until the refueler has secured and cleared the area.

Starter vehicles, jeeps, and auxiliary power units may not be used within 100 feet of fueling operations unless required to fuel aircraft.

Position of the truck should be as distant as the length of hose permits, preferably to the windward (upwind) side of the aircraft. It must be parked parallel to, or heading away from the wing, in position so that it may be driven away quickly in the event of fire. The truck should be driven away as soon as the refueling operation has been completed. Truck dome covers should be kept closed except when a tank is actually being loaded. The driver must always stay with his truck while refueling is in progress.

AVIATION LUBE OIL TRUCK

The newest aviation lube oil truck used aboard naval air stations is the MA-1A-1, 500-gallon aircraft lube oil service unit, which is mounted on a commercial-type truck chassis. (See fig. 10-8.)

The following is a brief description of the aircraft lube oil service unit:

1. A suction stub with dust cap, control valve, and strainer for pumping from an outside source is located at the left front of the vehicle.
2. The tank is built with a flat top which may be used as a service deck. It also permits full visibility from the cab.
3. The meter register protrudes through the top deck. The register is mounted on a swivel and can be turned to any direction for reading.

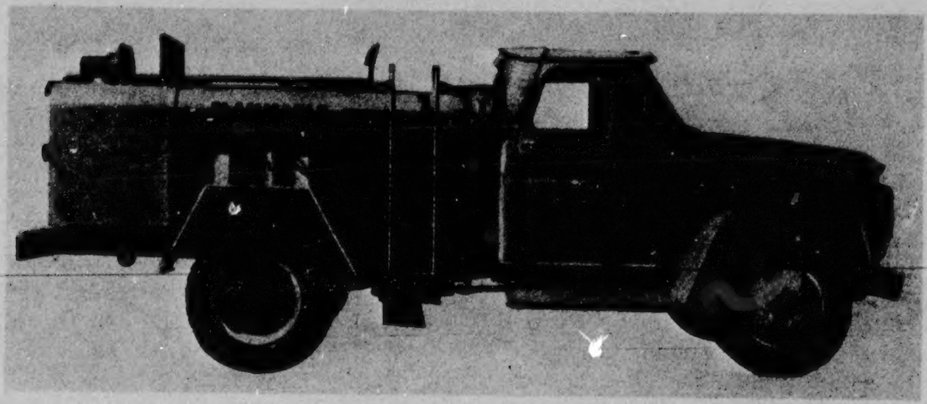

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Figure 10-8.—500-gallon aircraft lube oil service unit mounted on truck.

4. The tank is equipped with an oil recirculating system for the purpose of preheating the oil when required.

5. The hose may be unwound from the hose reel and used for servicing directly through the tank rear cabinet doors or through the door in the top deck of the tank.

6. The rear cabinet is provided with a light. It is operated by a push-pull switch.

7. A temperature gage is installed in the rear cabinet. It indicates the temperature of the oil in the tank heater box.

8. Two pressure gages are attached to the piping system in the rear cabinet. The high pressure gage (0-300 psi) indicates pressure within the system. The low pressure gage (0-100 psi) indicates the differential pressure across the filters. When the valves are set to pump out of the tank, the high pressure gage should read 45 psi.

9. A power takeoff (PTO) control with handbrake interlocking device is provided on the unit. The interlock prevents engagement of the power takeoff until the handbrake of the vehicle is engaged.

10. A vehicle engine tachometer is provided for determining correct engine rpm during servicing operations, and is located on the vehicle dashboard.

11. Power takeoff lock-out: A power takeoff lock-out air interlock system is provided to prevent simultaneous propelling of the vehicle and operation of the pumping equipment. The interlock system includes provisions that make it impossible to shift from vehicle drive to accessory drive or vice versa, unless the engine is running at idle speed. An additional safety feature is incorporated which makes it impossible to operate the auxiliary throttle when the vehicle drive line is engaged.

OPERATING PROCEDURES

Make sure the emergency valve and the 4-inch gate valve in the tank drain are open. The emergency valve is opened by moving the lever forward until it catches. The emergency valve operating lever is bolted to the deck to the right of the transmission shift lever. The 4-inch gate valve is operated from the left side of the chassis. A handwheel protrudes through the tank subframing.

NOTE: If the emergency or gate valve is not opened before starting the pump, the pump will operate with excessive noise and vibration. Prolonged operation with the valves closed will damage the pump. However, under certain conditions, when these valves are open, a hydraulic noise may occur in the pump. This is not detrimental to the pump.

Ensure that the vehicle handbrake is engaged, hand and foot throttles are in the normal position, and transmission is in the neutral position, then depress the clutch and move the PTO operating handle to the ON position.

SERVICING AIRCRAFT WITH LUBRICATING OIL

Make sure the proper valves are open for this operation. Follow the instructions on the plate located on the inside of the right rear cabinet door. Figure 10-9 shows this instruction plate.

Each valve has an identification plate on its handwheel. The numbers referred to on the instruction plate correspond to the numbers on the valve identification plates.

For this operation run the engine at 800 rpm. Engine speed is indicated by an electric tachometer located on the dash of the truck.

Operating instructions for preheating lube oil, pumping from an outside source, pumping out of the tank, and draining the tank are given in figure 10-9.

AIR TRANSPORTABLE DISPENSING SYSTEMS

TACTICAL AIRFIELD FUEL DISPENSING SYSTEM (TAFDS)

The Tactical Airfield Fuel Dispensing System (TAFDS) was originally conceived to fill a need for Marine Corps advance base airfields. This versatile fuel stowage and dispensing system provides a rapid means of storing and dispensing fuel. In a number of instances it has been temporarily used until permanent facilities could be provided.

The system is modular in design, air transportable, and simple in arrangement. A standard system consists of six collapsible pillow tanks, three pumping units, three filter/separators, three fuel quality monitors, three meters, and three manifolds. Sufficient hose, quick-disconnect couplings, valves, fittings, and dispensing nozzles are provided to permit simultaneous dispensing of fuel at 18 separate points.

Earlier systems were furnished with tanks of 10,000-gallon capacity each. Newer systems provide tanks at 20,000-gallon capacity each. Metal components are constructed of lightweight material wherever possible. The system can receive fuel from mobile tanks or from pipeline (hose line). It also can decant fuel from drums. A complete system can dispense fuel at a combined flow rate in excess of 1,000 gpm.

All safety precautions regarding fuel handling procedures outlined in NAVAIR 06-5-502 apply. Special attention should be given proper grounding of equipment by means of ground wires and rods which are provided with the systems.

HIGH SPEED AIR TRANSPORTABLE FUEL DISPENSING SYSTEM

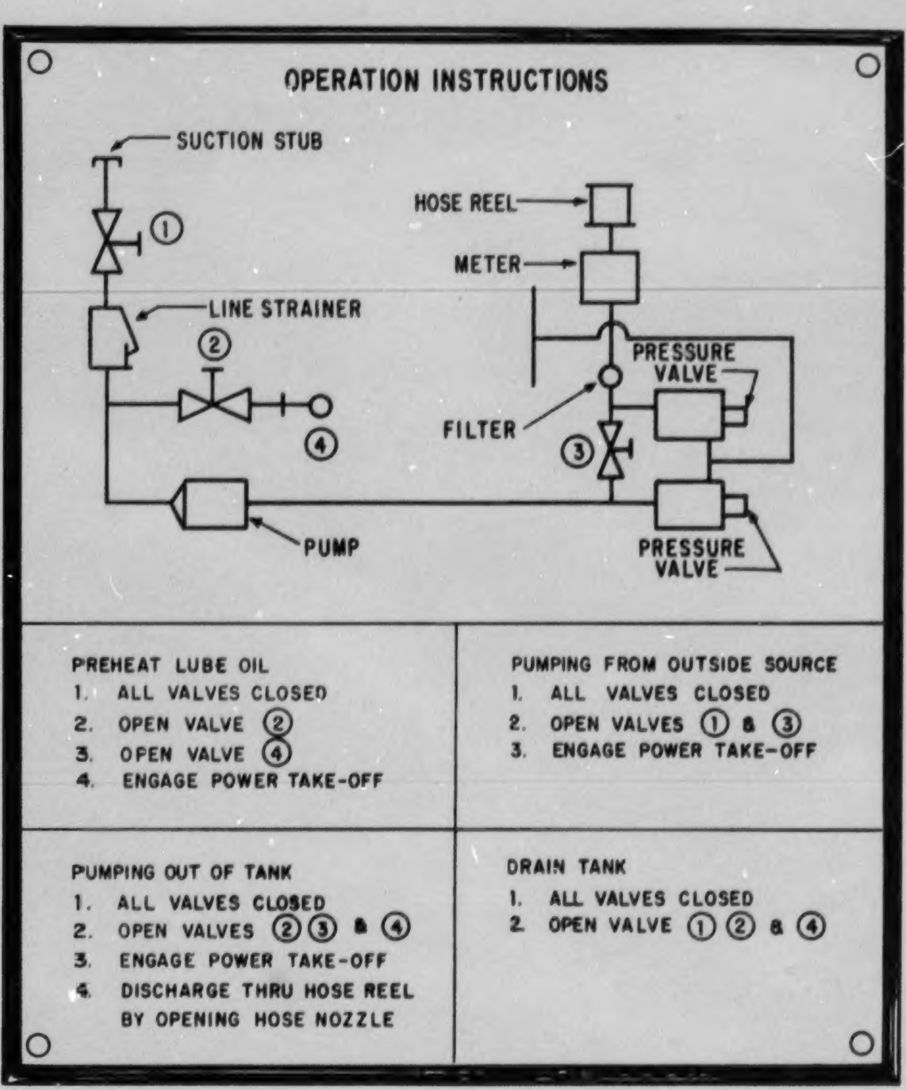
The high speed system is designed to fuel large aircraft, such as the C-133 and C-141, which require large quantities of fuel. This system allows rapid installation and transportation.

This system is modular in design and air transportable. Essentially, this system is similar to the Tactical Airfield Fuel Dispensing System (TAFDS), the difference being only in the stowage capacity and fuel flow rates. This system is capable of dispensing fuel at a rate of 600 gpm and employs collapsible pillow tanks of 50,000-gallon capacity each. Hoses, filter/separators, and meters are sized to be compatible with the 600-gpm flow rate.

HELICOPTER EXPEDIENT REFUELING SYSTEM (HERS)

The Helicopter Expedient Refueling System (HERS) is a fuel stowage and dispensing system primarily intended for refueling helicopters at advance bases. Small fixed-wing aircraft and ground vehicles may also be fueled where fuel flow rate requirements do not exceed 50 gpm through a single nozzle.

The system is modular in design and air transportable. Components are constructed of lightweight materials, when possible, to reduce the overall weight of the system. A standard



PREHEAT LUBE OIL
1. ALL VALVES CLOSED
2. OPEN VALVE ②
3. OPEN VALVE ④
4. ENGAGE POWER TAKE-OFF

PUMPING FROM OUTSIDE SOURCE
1. ALL VALVES CLOSED
2. OPEN VALVES ① & ③
3. ENGAGE POWER TAKE-OFF

PUMPING OUT OF TANK
1. ALL VALVES CLOSED
2. OPEN VALVES ②③ & ④
3. ENGAGE POWER TAKE-OFF
4. DISCHARGE THRU HOSE REEL BY OPENING HOSE NOZZLE

DRAIN TANK
1. ALL VALVES CLOSED
2. OPEN VALVE ① ② & ④

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Figure 10-9.—Instruction plate.

system consists of 12 collapsible fuel drums of 500 gallons capacity each, a 100-gpm pump driven by a gasoline engine, two 50-gpm filter/separators, two fuel quality monitors, and two flow meters. Sufficient rubber hoses with cam-type, quick-disconnect fittings and overwing and single point nozzles are provided for connection between components. Grounding rods and wire are also provided. Rollover protection is provided on the filter/separator and pump.

In theory, four of the collapsible drums will be installed at the fueling location, four will be in transit from the bulk stowage point, and the remaining four will be at the bulk stowage point being filled.

Chapter 11

FUELING, DEFUELING. AND PURGING AIRCRAFT FUEL SYSTEMS

This chapter deals with the fueling and defueling of aircraft aboard carriers and ashore. The equipment employed to perform these operations is also discussed.

The equipment described in this chapter is operated and maintained by the ABF3 and ABF2. Similarly, the procedures discussed are those performed essentially by these ABFs.

CARRIER FUEL CREWS AND EQUIPMENT

The fueling and defueling of aircraft and the operation of the aviation fuel systems are directed through the Aviation Fuels Control Center. This control center is manned by the aviation fuels officer, aviation fuels chief, division leading petty officer, and a sound-powered phone talker. The flight deck and the hangar deck fuels petty officers work out of this control center. The fueling and defueling of aircraft are performed by fuel crews that man the station and perform the fueling operations.

The basic fuel crew consists of a crew leader; phone talker; and two or three men to handle the CO_2 or dry chemical fire extinguisher, swab, and the fueling hose. The number of crews vary according to the number of men assigned to the division and the operational requirements.

The crew leader's responsibilities are to ensure that the proper operating procedures are carried out and that the necessary safety precautions are observed by the fueling crew. He reports directly to the flight or hangar deck fuels petty officer.

The sound-powered phone talker is in direct communication, via the 4JG circuits, with the control center and the pumprooms. The control center informs the fuel crew, via the phone talker, as to the aircraft to be fueled and the fuel load required. The phone talker normally operates the controls for the fuel station.

The other members of the crew pull out the hose from the station and attach it to the aircraft. One of the men must man the CO_2 bottle throughout the fueling operation. Another man is prepared to swab up any spilled JP-5 or spread out any spilled AvGas so that it will evaporate more readily. On the flight deck, where the spill is so large that it cannot be taken care of by one or two swabs, the crash and salvage repair team should be requested to provide additional men with fire bottles (CO_2 and dry chemical) and to wash down the spill with fire hoses. Hangar deck spills must be taken care of with swabs.

PRESSURE FUELING NOZZLE

The pressure fueling nozzle is designed to connect to all NATO military aircraft, and is used to control the flow of fuel during pressure fueling operations. The nozzle inlet port is coupled to a 2 1/2-inch fueling hose, and the outlet port attaches to a mating adapter installed on the aircraft.

The Parker nozzle is the most widely used in the Navy; therefore, it is the only one discussed in this training manual.

Parker Nozzle

The operation of the nozzle is mechanical, through manual control. A poppet valve seals the nozzle outlet port against fuel leakage when it is not attached to a mating adapter. The control handle is locked against operation until after the nozzle is coupled to the adapter. This coupling action compresses the nose seal on the nozzle against the sealing surface of the bayonet flange in the adapter to form a fluid-tight connection from the fuel supply to the aircraft fuel system. Completion of this action unlocks the valve flow control handle so that subsequent rotation of the handle lifts the poppet valve up into the adapter and opens a passage into the fuel manifold of the aircraft. A petcock installed on the side of the nozzle is used for taking fuel samples during the fueling operations. Figure 11-1 shows the Parker nozzle, aircraft adapter, and the fuel sampling petcock valve.

OPERATING PROCEDURES.—The following operating procedures cover only those procedures necessary for operating the nozzle. Aircraft fueling procedures are covered later in this chapter.

Remove the safety cap from the aircraft adapter valve and the dust cover from the nozzle. Lift the nozzle by the lifting handles and align the slots on the nozzle with the lugs on the adapter valve.

Press firmly to depress all three nozzle lock keys. Then, using the lifting handles, rotate the nozzle clockwise to a definite and positive stop. In the fully locked position, the sequence rod will position itself to unlock the flow control handle.

To commence fueling, rotate the flow control handle to the full open position. (The handle must rotate more than 180 degrees to insure that the poppet valve is fully open and locked by toggle action.) Do not partially open the handle.

At the completion of fueling operations, close the flow control handle completely before attempting to uncouple. (The handle must rotate shut more than 180 degrees and lock shut by toggle action.) Using the lifting handles, rotate the nozzle counterclockwise to clear the adapter lugs and disengage. Immediately replace the dust cover on the nozzle, and the safety cap on the aircraft adapter.

IN-FLIGHT REFUELING PROBE ADAPTER

The in-flight refueling probe adapter is designed to connect the aircraft refueling probe to the pressure fueling nozzle. Figure 11-2 is an illustration of this adapter.

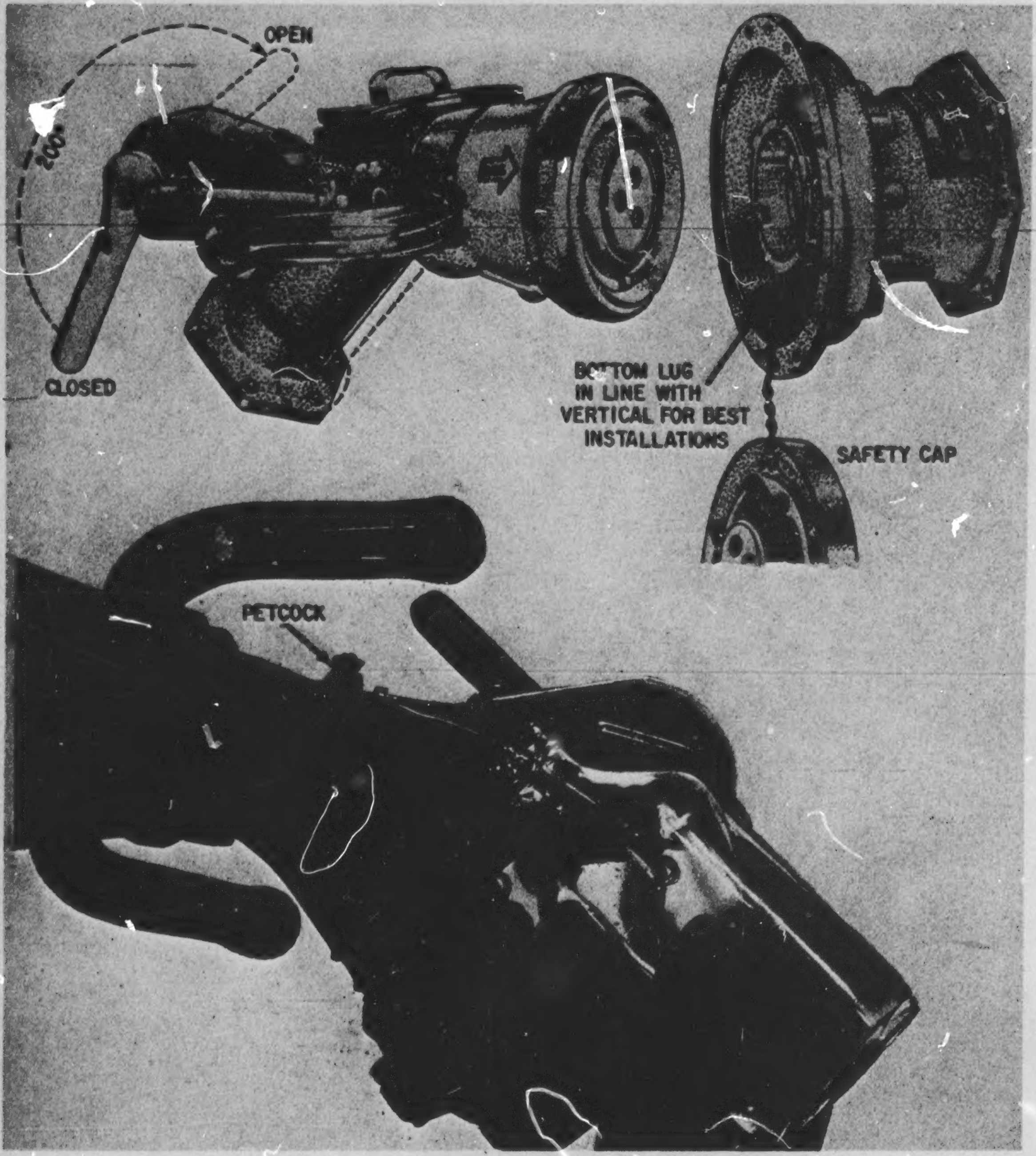
The adapter is connected to the in-flight refueling probe by sliding the adapter over the probe nozzle. Spring-loaded balls in the adapter lock it onto the probe nozzle by dropping into a groove around the nozzle. An O-ring in the adapter contacts the nozzle, making a fuel-tight seal. The placing of the adapter onto the probe nozzle also opens the valve in the probe nozzle. A fitting on the other end of the adapter is designed to connect to a pressure fueling nozzle. See figure 11-3 for the installation or connection. With the pressure fueling nozzle connected to the adapter, opening the nozzle allows fuel to flow directly into the aircraft's fuel system. The adapter is released from the probe nozzle by squeezing the two handles together on the probe.

Operating Procedures

Remove the cap and plug from the adapter. Position the adapter over the probe nozzle and push the adapter onto the probe. It may be necessary to squeeze the release handles together to relieve the spring load on the locking balls. When the adapter is locked onto the probe, connect the pressure fueling nozzle to it. When ready to commence fueling, open the pressure fueling nozzle. To prevent damage to the probe, it may, in some instances, be necessary to support the weight of the adapter (20 pounds), the pressure refueling nozzle (10 pounds), and the fueling hose from the probe to prevent damage to it.

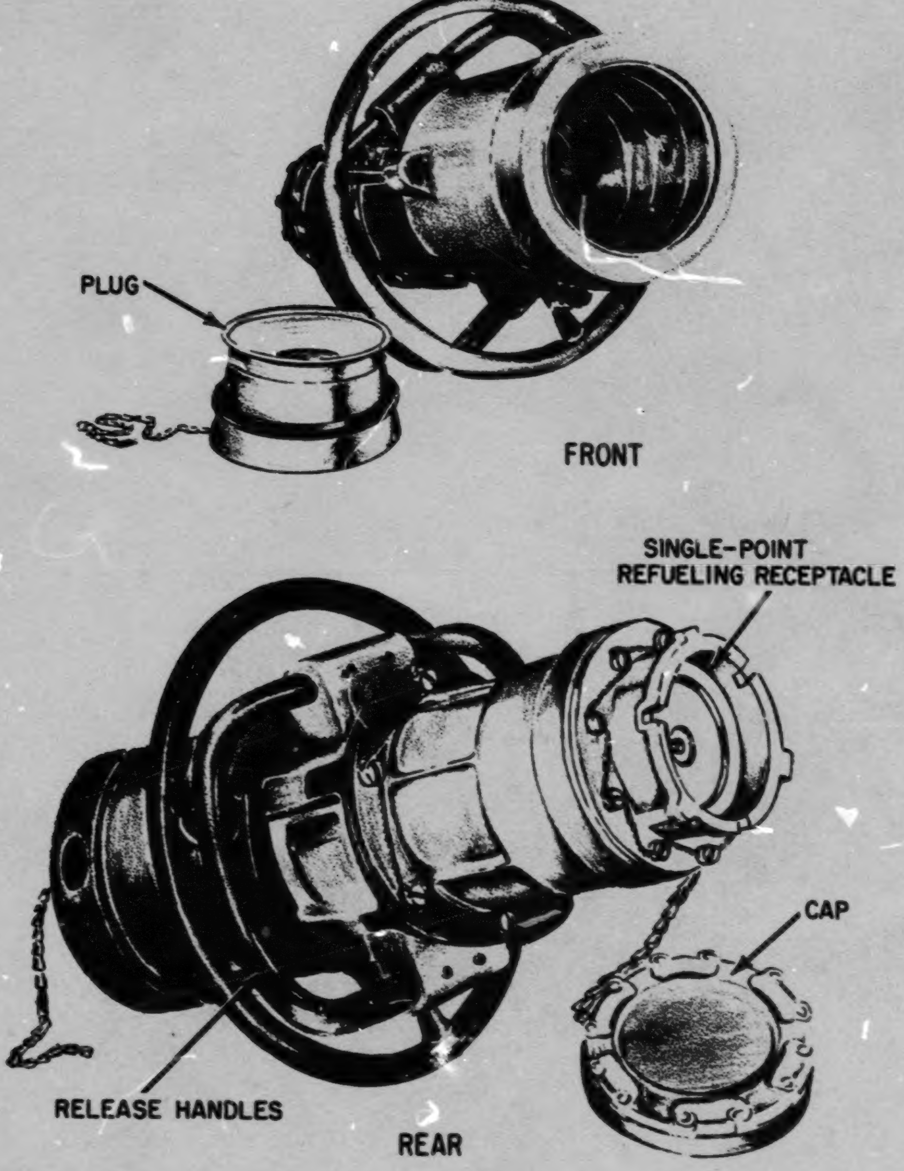
When the fueling or testing is completed, stop the flow to the nozzle and close the nozzle. Remove the pressure nozzle first and then, by squeezing the two release handles together, pull the adapter from the probe nozzle. Install the plug and cap in/on the adapter immediately.

CAUTION: Personnel not currently familiar with the procedures for refueling by use of the


OPEN
200°
CLOSED
BOTTOM LUG IN LINE WITH VERTICAL FOR BEST INSTALLATIONS
SAFETY CAP
PETCOCK

197.74

Figure 11-1.—Parker nozzle and aircraft adapter.


PLUG
FRONT
SINGLE-POINT REFUELING RECEPTACLE
CAP
RELEASE HANDLES
REAR

197.75

Figure 11-2.—In-flight refueling probe adapter.

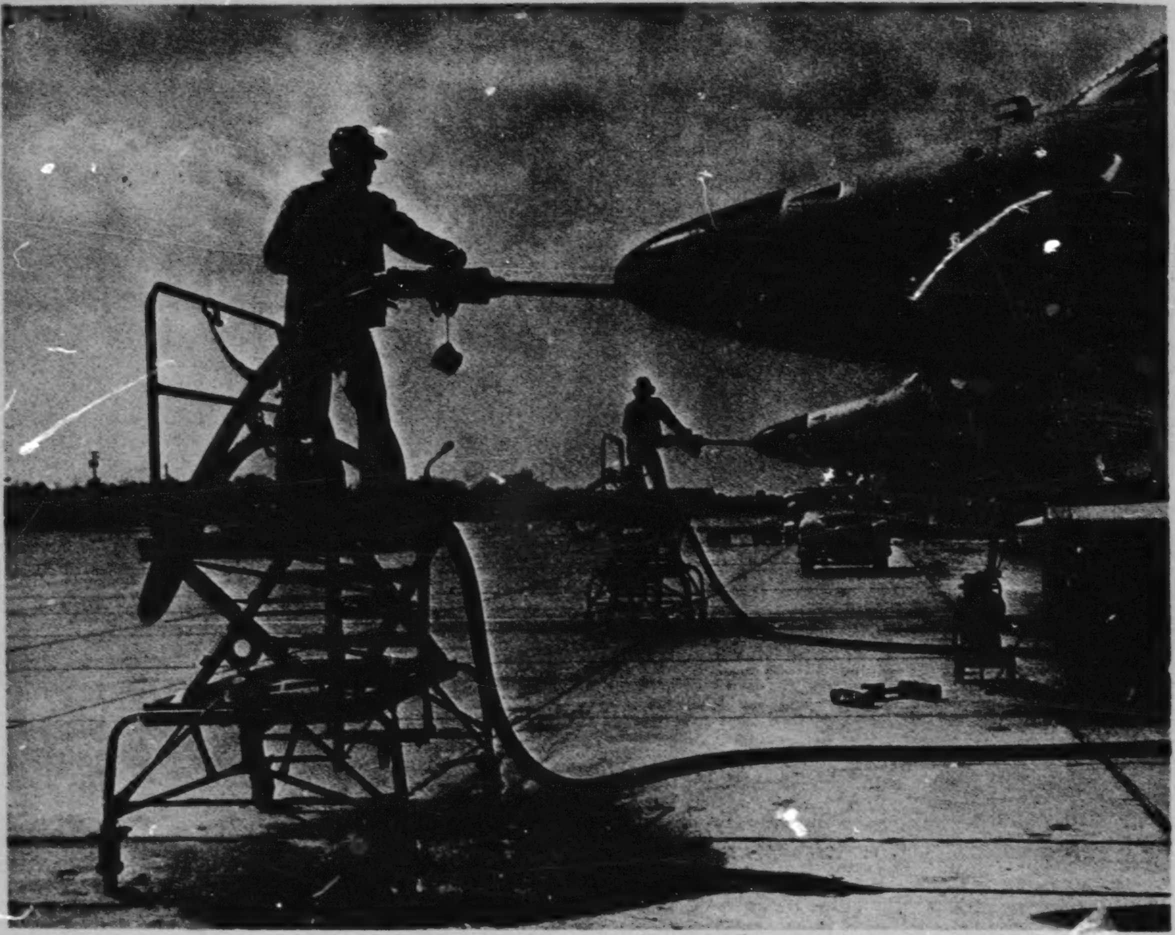


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Figure 11-3.—In-flight probe refueling.

in-flight refueling probe should review thoroughly applicable material in the aircraft technical manual for the particular aircraft in question. Where provided, ship, squadron, air wing/group, station, etc., procedures should be reviewed and followed meticulously.

GRAVITY FUELING NOZZLE

A gravity fueling nozzle is a manually controlled nozzle attached to the end of a fuel hose and is inserted directly into the fuel tank. The nozzle is actually a valve for controlling the rate of fuel flow and is so designed that it will close automatically when hand pressure is released. A typical gravity fueling nozzle is shown in figure 11-4.

Squeezing the control lever toward the nozzle handle allows fuel to flow through the nozzle. A dual valve in the nozzle allows a gradual opening or closing of the nozzle.

The control lever presses against the valve stem and lifts a small valve disc which is held against its seat by a compression spring. Opening the smaller valve avoids a sudden flow of fuel and is known as cracking the valve. After

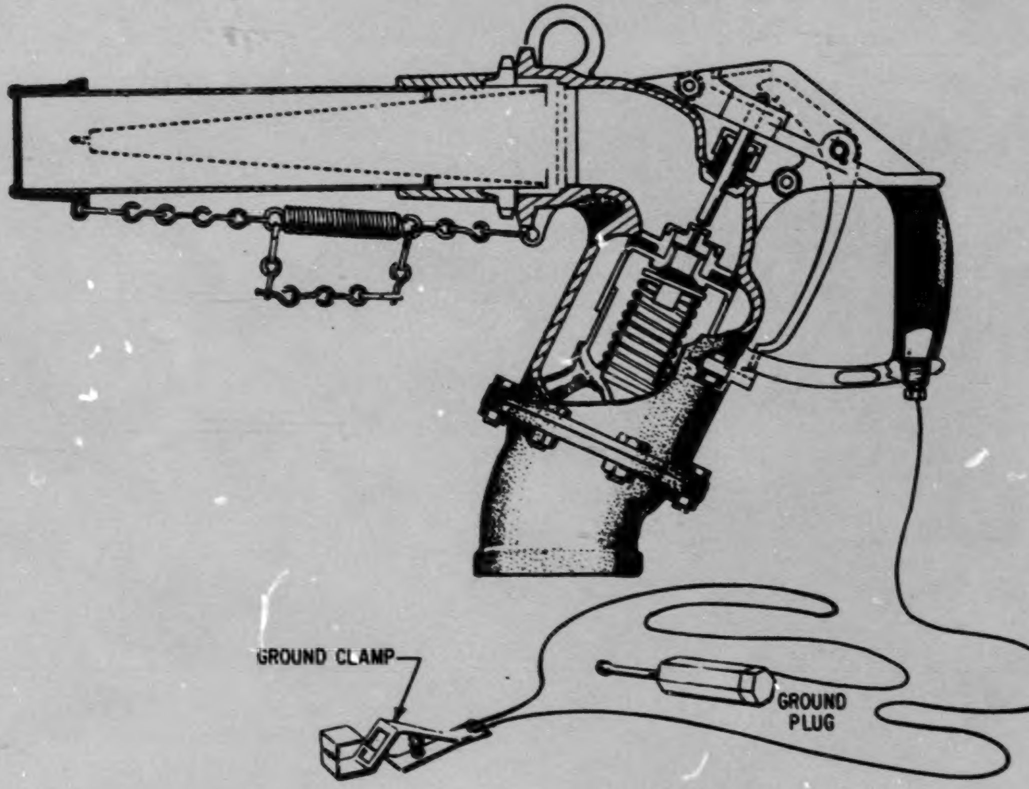

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Figure 11-4.—Gravity fueling nozzle.

cracking, the continued action of squeezing the handle depresses the valve stem farther, and a shoulder on the stem meets the large disc assembly, opening the valve fully. In closing the nozzle, the operation is reversed and the larger valve disc closes first. The small stream still coming through the valve relieves the stress on the hose that would result if the complete flow were suddenly stopped. Fully releasing the control lever closes the smaller valve, and the nozzle is then completely closed.

Operating Procedures

Never block the gravity fueling nozzle in an open position. Ratcheted handles that allow the operator to lock the handle in the open position are prohibited. It must always be controlled by hand so that the flow of fuel may be instantly stopped when necessary. A strainer or screen installed in the nozzle provides a last means of stopping any dirt or foreign matter from entering the aircraft fuel tanks. This strainer should never be left out of the nozzle if it is to be used for fueling aircraft.

FUELING HOSE AND ADAPTERS

There are three types of fueling hose in use at the present time for fueling aircraft. On those carriers having power-operated hose reels, 2 1/2-inch hard hose is provided for defueling purposes, though it can be used for fueling. On those carriers having only manually operated hose reels, 2 1/2-inch collapsible hose is provided for fueling, as it is more easily stowed on the reel. Most carriers also have a 1 1/2-inch hard hose for use as a defueling hose and for fueling from the AvGas stations.

Hoses used for the handling of aviation fuels must be constructed of a fuel-resistant rubber. The end fittings are normally made of brass and have standard hose threads. Pipe fittings should never be used for hose connections, as the standard pipe thread will not mesh properly with the hose thread.

There are adapters available for connecting either the pressure fueling nozzle or the gravity fueling nozzle to either the 2 1/2-inch or 1 1/2-inch hose. The adapters and connections for fitting each type nozzle to each type hose are shown in figure 11-5.

When a new hose, or one which has been out of service for some time, is placed in service, a discoloration and/or solid contamination of the fuel may take place.

The procedures for installing a new hose or reinstalling an older hose are as follows:

1. Flush the hose with the type of fuel to be used.
2. Cap one end of the hose and fill with fuel (with the other end elevated); cap the other end and allow to stand for one week.
3. If discoloration or contamination is observed, flush and refill daily until the discoloration or contamination disappears.

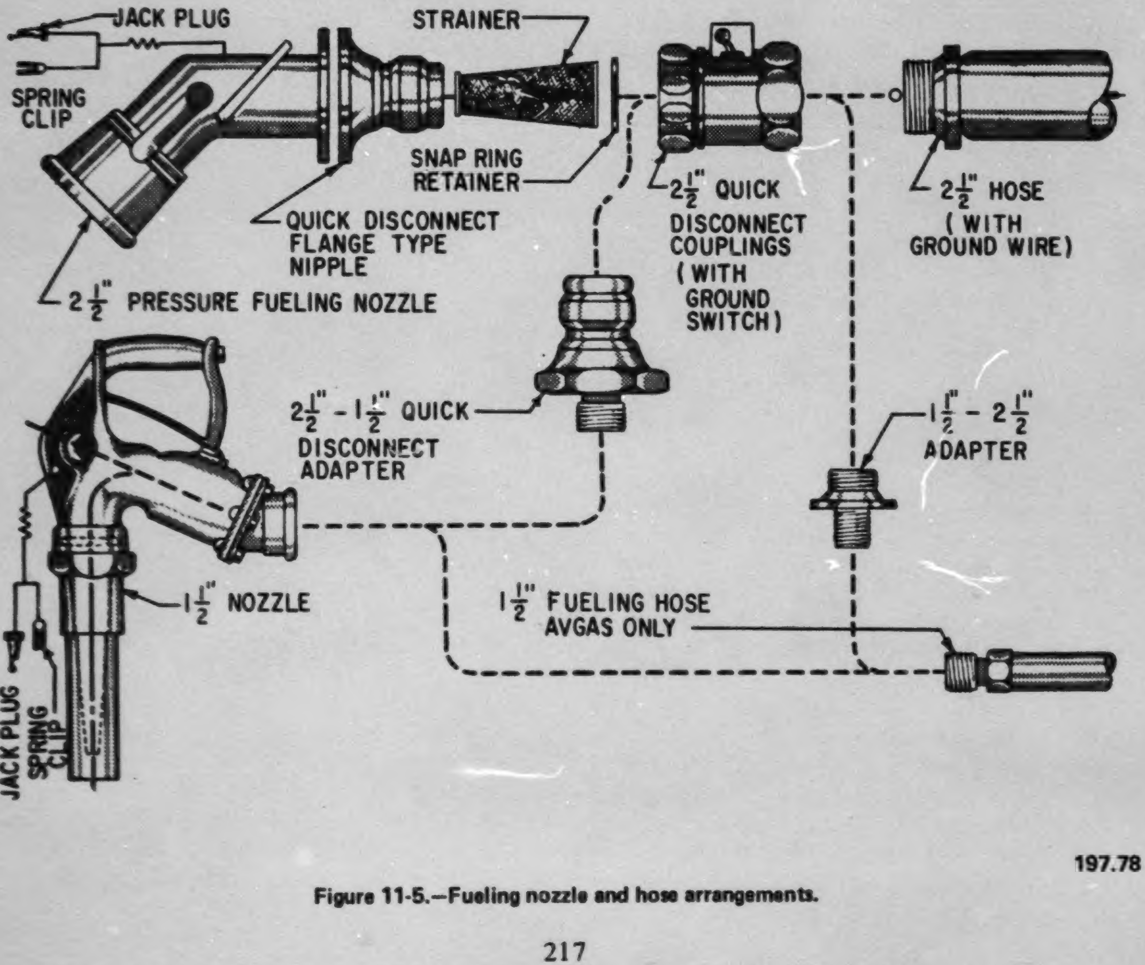
JACK PLUG
STRAINER
SPRING CLIP
SNAP RING RETAINER
QUICK DISCONNECT FLANGE TYPE NIPPLE
2½" PRESSURE FUELING NOZZLE
2½" QUICK DISCONNECT COUPLINGS (WITH GROUND SWITCH)
2½" HOSE (WITH GROUND WIRE)
2½" - 1½" QUICK DISCONNECT ADAPTER
1½" - 2½" ADAPTER
1½" NOZZLE
1½" FUELING HOSE AVGAS ONLY
JACK PLUG
SPRING CLIP
197.78

Figure 11-5.–Fueling nozzle and hose arrangements.

4. Flow a minimum of 5,000 gallons of fuel through the hose back to the stowage tank. Upon completion, verify the fuel contamination by laboratory test or the AEL Mk III Contaminated Fuel Detector.

5. After all of the above procedures have been taken, if the hose still delivers contaminated fuel, remove the hose for further disposition.

SAFETY CANS

The aviation fuel safety can is used for servicing equipment, for venting the fuels system, for draining the last small amounts of fuel from a defueled aircraft, and many other purposes. Fuel drained from the aviation fuel system, aircraft, or any other source that cannot be disposed of immediately must be stored in a safety can until it can be. The safety cans should always be marked to show the type of fuel in the can (e.g., AvGas, JP-5 or contaminated fuel).

The can is equipped with a carrying handle, a trigger arm which operates the outlet valve and a vent, a flexible metal pouring nozzle, a ground wire, and a combined strainer and flash arrester at both the fill opening and the nozzle.

Before filling the can, the ground wire from the aviation fuel hose nozzle should be connected to the can. Before pouring fuel from the can, the ground wire on the can must be connected to the tank which is to be fueled.

PORTABLE DEFUELING UNIT

The portable defueling unit is an air-motor-driven pump used aboard carriers for the defueling of aircraft. The pump is a horizontal, positive-displacement rotary pump of the internal gear type. It is connected to an air-motor through a flexible coupling. The air-motor is powered by air pressure from the ship's low-pressure air system.

There are three hoses used with the defueling unit: an air hose, 1/2- or 3/4-inch inside diameter and two defueling hoses, 1 1/4- or 1 1/2-inch inside diameter. One defueling hose is used as a suction hose. It should be only as long as necessary to reach from the aircraft to the defueling unit. The longer the hose the less effective the defueling unit will be. The other defueling hose is used for the defueling unit discharge hose. The length of this hose has little effect on the defueling unit operation as long as it does not become kinked.

Operating Procedures

The defueling suction hose is connected to the aircraft in several different ways. For jet aircraft having single point fueling/defueling capability, the hose is connected to the aircraft through a pressure fueling nozzle. For reciprocating engine aircraft, the hose, without a fitting, is inserted into the tank fill opening or pushed up over a drain fitting on the bottom of the tank. When defueling drop tanks only, the method normally used is inserting the defueling suction hose into the tank through the tank fill opening. For total defueling, defuel through the aircraft pressure fueling adapter.

The discharge hose from the defueling unit is connected to the fill connection through a special fitting.

On some carriers not equipped with automatic fuel/defuel valves, a special defueling main is led from the JP-5 fill connection to several points on the hangar deck and flight deck for use with the portable defueling unit. When defueling back into the system, care must be taken to ensure that the fuel is not contaminated or of a different grade from that in the system. NEVER defuel JP-4 back into the JP-5 system.

NOTE: Never defuel JP-5 containing red dye back into the system.

AIRCRAFT FUELING AND DEFUELING PROCEDURES

The procedure for fueling an aircraft aboard a carrier equipped with the automatic fuel/defuel valve is as follows:

1. Before the fueling operation is begun, the below deck Aviation Fuels Systems Operation Instructions must be completed.

2. Reel out the fueling hose. GROUND THE AIRCRAFT TO THE SHIP AND THE HOSE NOZZLE TO THE AIRCRAFT. Attach the hose nozzle to the aircraft. Ascertain that the nozzle switch is in the OFF position.
3. Open the defueling pump discharge valve and the hose reel cutout valve.
4. Check the gage on the station supply riser to ascertain that sufficient fuel pressure is available.
5. Start the defueling pump.
6. With the nozzle closed, place the nozzle switch in the ON position. This will energize the solenoid-operated pilot valve for the automatic fuel/defuel valve and place the station in the fueling position.
7. Ascertain that positive pressure is showing on the gage downstream of the automatic fuel/defuel valve; then proceed with the fueling operation.
8. When the fueling operation is completed, evacuate the hose by placing the nozzle switch in the OFF position. This will deenergize the solenoid-operated pilot valve and place the automatic fuel/defuel valve in defueling position.
9. When the hose is drained, stop the defueling pump and close all valves that were opened for the operation.

The procedure for fueling an aircraft aboard a carrier equipped with Blackmer or Wayne fueling stations is as follows:

1. Before the fueling operation is begun, the below deck Aviation Fuels System Operation Instructions must be completed.
2. Reel out the collapsible hose. GROUND THE AIRCRAFT TO THE SHIP AND THE HOSE NOZZLE TO THE AIRCRAFT. Ascertain that the nozzle switch is in the OFF position.
3. Open the hose reel cutout valve.
4. Check the gage on the station supply riser to ascertain that sufficient fuel pressure is available.
5. Start the station pump.
6. With the nozzle closed, place the nozzle switch in the ON position. This will energize the solenoid valve for the 4-way valve assembly.
7. Proceed with the fueling operation.
8. When the fueling operation is completed, evacuate the hose by placing the nozzle switch in the OFF position. This will deenergize the solenoid valve and place the 4-way valve assembly in the defueling position.
9. Drain the hose, stop the station pump, and close all valves that were opened for the operation.

The procedure for defueling an aircraft aboard a carrier with the automatic fule/defuel valve type station is as follows:

1. The defueling of aircraft can be accomplished simultaneously with fueling operations in the same quadrant or can be accomplished as a separate operation.
2. The fueling station should be set up as previously described for fueling operations.
3. Reel out the hard hose. GROUND THE AIRCRAFT TO THE SHIP AND THE HOSE NOZZLE TO THE AIRCRAFT.
4. Start the defueling pump. Shift the controls to the fueling position and prime the hose line for about 12 seconds. Then shift the controls to the defueling position.
5. After defueling is complete, close the hose nozzle and allow the defueling pump to run until the hose is emptied. Remove the nozzle and the ground wires.

AIRCRAFT PRESSURE FUELING PROCEDURES

The fueling procedures discussed here are for an imaginary aircraft which is a combination of all naval pressure fueled aircraft. The illustrations are of the A-6A aircraft which is typical of pressure fueled aircraft. Do not attempt to fuel any aircraft without carefully reviewing and following the procedures spelled out in the technical manuals for that aircraft.

No radar or radio equipment operation is permissible within 75 feet of an aircraft while it is being fueled because the power output of the radio and radar equipment creates a very serious fire hazard. Grounding of the aircraft, the refueling equipment, and the refueling nozzle to the aircraft is necessary to guard against static electric sparks. The aircraft must be grounded before attaching the refueling nozzle to the aircraft.

The nozzle ground wire must be attached to the aircraft before the nozzle is connected because the fuel flowing in the hose can create a static charge in the nozzle. If the nozzle does not have a ground wire, touch the nozzle to the bare metal of the aircraft before removing the adapter safety cap. If a mobile refueler is being used, it must be grounded before the nozzle ground wire is attached to the aircraft. Nonmobile refueling equipment installations are permanently grounded.

All refueling personnel must be properly instructed and be thoroughly familair with their jobs before fueling the aircraft.

Each time the aircraft is fueled, the primary and secondary prechecks must be performed according to procedure to make sure that the shutoff valves are working properly. Aircraft fuel vents must be checked as specified in the aircraft technical manuals by feeling the airflow escaping from the tank vents during fueling. The vents must not be blocked by cupping the hand over them during fueling because the fuel tanks may rupture and cause serious injury as well as damage to the aircraft.

The procedures for fueling the aircraft are as follows:

1. Check to ensure that the aircraft, fueling unit, and pressure fueling nozzle are grounded.
2. Open the fueling station access doors.
3. Station men at the vent outlets as directed in the aircraft technical manuals. (See fig. 11-6.) These men are to feel, by hand, air being vented as the fuel is loaded into the tanks. (Vent monitors are not required if there are tank pressure gages or overpressure warning lights at the refueling panel.)
4. Station one man (normally the plane captain) in the cockpit to operate the necessary switches, observe the fuel quantity gages, and give the required signals to the man stationed at the fueling station control panel. Both engine and fuel master switches must be set to OFF. Set the switches on the fuel management panel as directed by the aircraft technical manuals.

Refer to figure 11-7 for the fuel station and controls for an A-6A.

5. Station one man at the fueling station control panel to operate the necessary switches and to connect and operate the pressure fueling nozzle in accordance with the signals given by the man in the cockpit. Set the fueling and precheck control switches as directed in the aircraft technical manuals.
6. Connect external ac electrical power to the aircraft if required. It is very important to follow the procedures outlined in the technical manuals.
7. Ensure that the pressure fueling nozzle is grounded to the aircraft. Remove the safety cap from the pressure fueling adapter and connect the nozzle to the adapter.
8. The man stationed at the aircraft fueling panel opens the fueling nozzle all the way and starts the flow of fuel into the aircraft. The man in the cockpit of the aircraft watches the fuel quantity gage while the fueling station operator watches the fueling station or mobile refueler flowmeter.
9. The man in the cockpit notes the readings on the fuel quantity gage and, when ready, signals CHECK PRIMARY, using the signals shown in figure 11-8.
10. The man at the aircraft fueling panel then sets the precheck switch to primary (PRI). Fuel flow should start again and automatically stop before the fuel quantity gage indicates the maximum pressure stated in the aircraft manual. If the flow does not stop automatically, the man in the cockpit signals STOP FUEL.

NOTE: The man in the cockpit should continue to monitor the fuel quantity gage for at least 30 seconds after each precheck shutoff. If the fuel flow rate after shutoff exceeds the rate specified in the aircraft manual, he should signal STOP FUEL. The man stationed at the aircraft fueling panel should monitor the fuel flow indicator (if installed) for at least 10 seconds after precheck shutoff. If the fuel flow exceeds the specified amount for the aircraft after shutoff or the man in the cockpit signals STOP FUEL, shut off the fuel nozzle, disconnect the nozzle from the aircraft, and notify the proper maintenance chief.

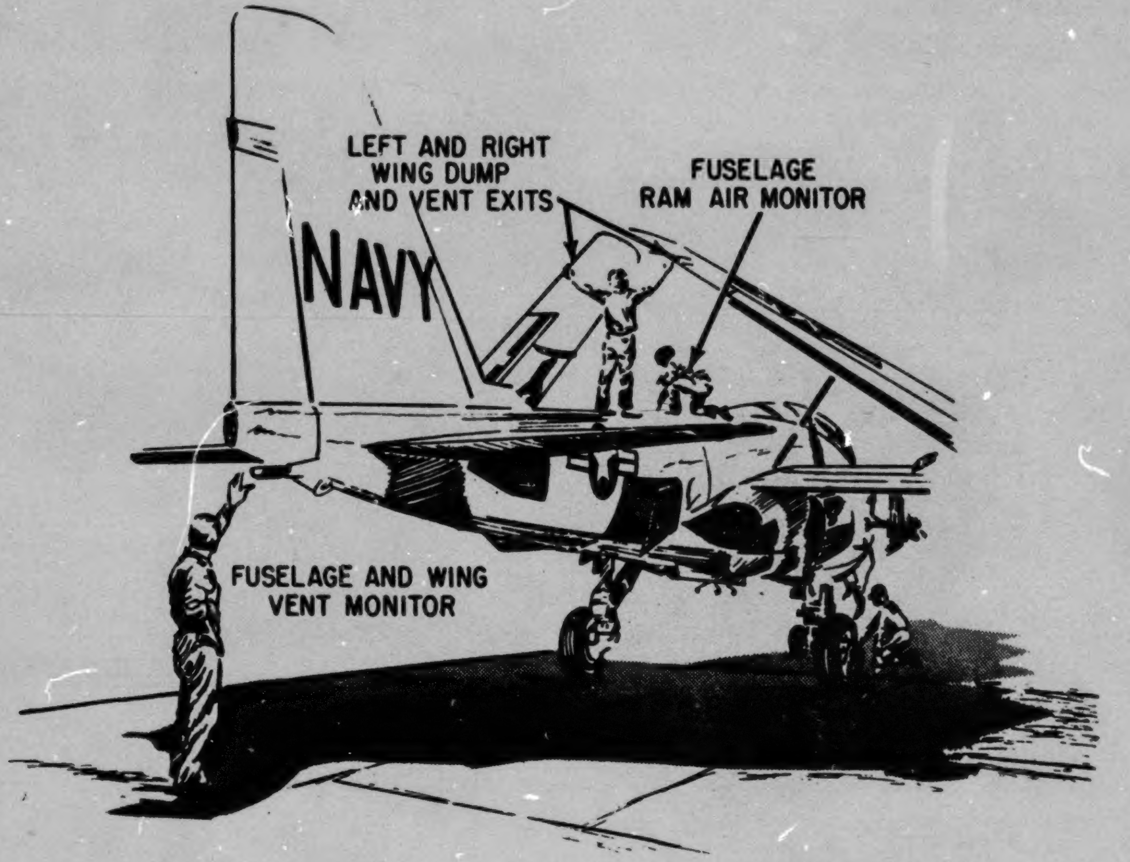
LEFT AND RIGHT WING DUMP AND VENT EXITS
FUSELAGE RAM AIR MONITOR
NAVY
FUSELAGE AND WING VENT MONITOR
197.79

Figure 11-6.–A-6A vent monitor positions.

11. If drop tanks are to be fueled, set the DROP TANK switches to HOLD and repeat step 8. If the fuel shuts off properly, set the DROP TANK switches to FUEL and accomplish refueling as necessary.

12. On signal from the man in the cockpit, set the precheck switch to SEC and repeat step 8.

13. If shutoff checks properly in steps 8, 9, 10, and 11, set the precheck switches to OFF. Set other switches as directed in the aircraft technical manuals. (Normally, all desired switches are set to FUEL. The A-6 has a slightly different procedure.)

14. The vents must be constantly checked to ensure that air flows from the vents while fueling is proceeding.

CAUTION: If no airflow is felt at a particular vent, at the beginning of fueling, the man at the aircraft fueling panel must be informed. The aircraft fueling panel operator checks to see if the tank has shut off. If the tank has shut off, he may continue fueling. If the stoppage of vent flow is not due to a tank shutoff, fueling must be stopped immediately and the proper maintenance chief notified.

15. Fuel flow into the aircraft will stop automatically when the tanks selected are filled,

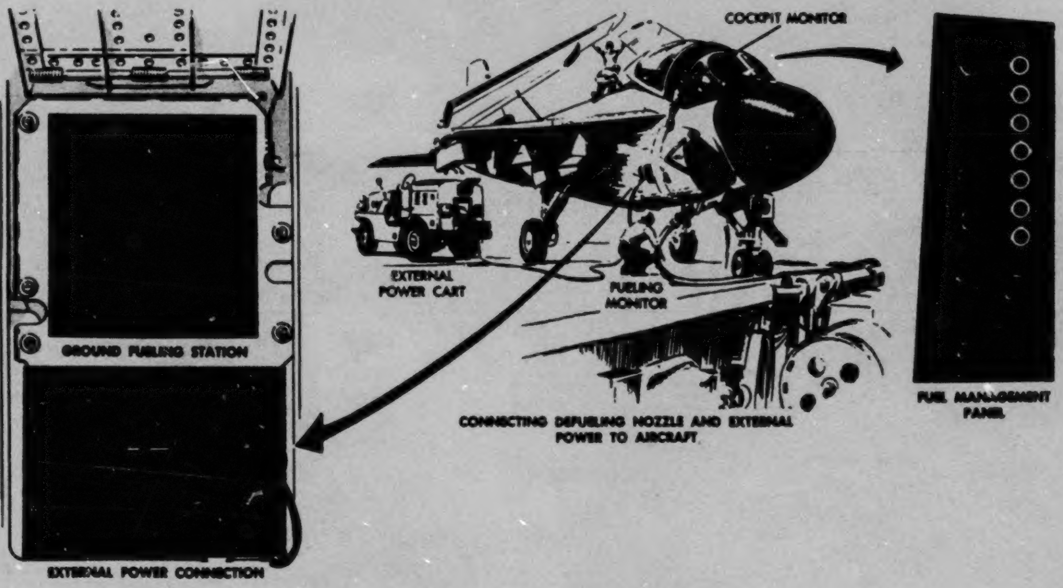
COCKPIT MONITOR
EXTERNAL POWER CART
FUELING MONITOR
GROUND FUELING STATION
CONNECTING DEFUELING NOZZLE AND EXTERNAL POWER TO AIRCRAFT
FUEL MANAGEMENT PANEL
EXTERNAL POWER CONNECTION

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Figure 11-7.—A-6A fueling stations and controls.

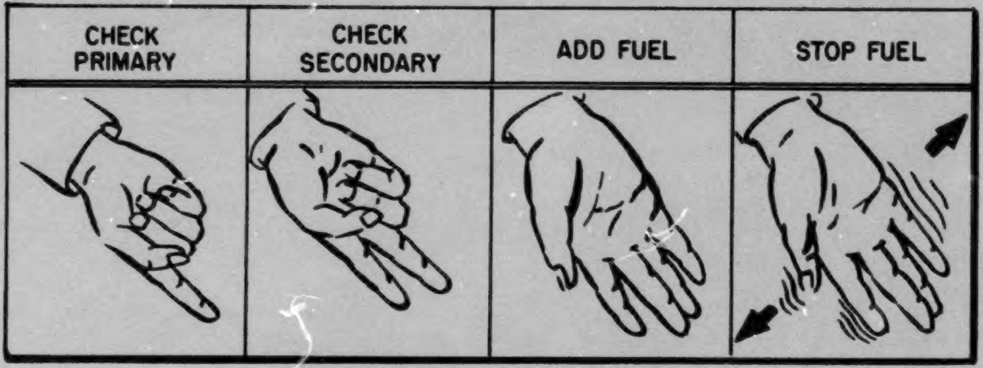
CHECK PRIMARY
CHECK SECONDARY
ADD FUEL
STOP FUEL

Figure 11-8.—Fueling hand signals.

197.81

or all fuel selector switches are set to HOLD or PRECHECK, or fuel flow may be stopped manually by closing the pressure fueling nozzle when the desired fuel load is reached.

16. After the desired fuel load has been obtained, close off the nozzle and remove it from the aircraft. If external power has been used, place the POWER switch to OFF.

17. Remove the external power cable and the ground wires.

AIRCRAFT REFUELING WITH ENGINES OPERATING (HOT REFUELING)

Hot refueling procedures are similar to normal refueling procedures, but make special allowances and outline special precautions. This is because of the increased danger of fire and/or injury and because communication between fueling crewmembers is much more difficult when the engines are operating.

Because prechecking, vent monitoring, grounding, and switch sequencing are the same for hot refueling and normal fueling, detailed explanations of these operations are not presented here.

For information, the functions of the pilot, chock and chain crew, and fire crew are also given.

The procedures for hot refuling aircraft are as follows:

1. One man is stationed at the fuel pit to operate the fueling equipment and to stop fuel flow to the aircraft in an emergency.

2. One man is stationed at the refueling nozzle to control fuel flow into the aircraft and to perform the precheck operations.

3. Men are assigned to monitor the aircraft vents if the aircraft does not have a tank pressure gage or overpressure warning lights.

4. Men are assigned to chock the aircraft when it is positioned in the fueling pit.

5. The plane captain meets the aircraft outside the fueling pit, performs the necessary inspections, and directs the aircraft into the pit.

6. The aircraft pilot remains in the cockpit, selects fuel loading, ensures that the cockpit switches are in the proper positions, and maintains UHF radio contact with the tower.

7. The pilot, before entering the pit, secures all electronic and electrical equipment not required for refueling. He signals the plane captain that the equipment is secured.

8. The pilot places all armament switches to the safe position and signals the plane captain that he has done so.

9. The pilot stops the aircraft so that the plane captain can check the aircraft for hot brakes. If the aircraft has hot brakes, the plane captain directs it away from the pits.

10. The pilot and plane captain perform all other checks and inspections required and determine fuel state and the quantity of fuel to be added.

11. In the meantime, the other members of the refueling crew check the pit area for any loose objects which might be ingested by the aircraft.

NOTE: The fuel crew must be constantly alert to maintain the cleanliness of the fueling pit as serious damage to an aircraft engine can result from ingesting a rag, piece of paper, or a small piece of metal.

12. After all the above checks and inspections have been completed, the pilot taxis the aircraft into the fuel pit under the guidance of a qualified aircraft director.

13. The aircraft is then chocked by assigned personnel.

14. The plane captain grounds the aircraft before any other connections are made.

15. The nozzle operator attaches the ground wire to the aircraft, attaches the nozzle to the aircraft, performs the prechecks, and remains at the nozzle until the refueling operation is completed. If the aircraft is to be refueled through the in-flight refueling probe, a workstand with guard rails is positioned by the refueling probe, the nozzle operator attaches the nozzle adapter to the probe, grounds the nozzle to the adapter, and attaches the nozzle to the adapter.

16. After the nozzle is attached and all inspections are made, the plane captain notifies the pit operator of the quantity of fuel to be added and to open the delivery valve.

17. The plane captain then signals the nozzle operator who slowly opens the nozzle to check for leaks. If leaks are found, the nozzle is shut immediately, and the plane captain is notified.

18. The prechecks are then performed on signal from the pilot or plane captain.

19. Vent monitors check the vents for airflow unless the aircraft is equipped with a tank pressure gage or warning light.

20. If vents and prechecks are functioning properly, the fueling commences and continues until the pilot signals the plane captain that the desired fuel has been added.

21. The plane captain then signals the pit operator who shuts off the fuel, evacuates the hose, and then signals the plane captain and nozzle operator that this has been accomplished.

22. The nozzle operator then shuts off the nozzle, disconnects the nozzle, and removes the nozzle ground wire from the aircraft.

23. All connections with the aircraft are removed, all workstands and ladders are moved clear of the aircraft, and the grounding wires are removed from the aircraft.

24. The plane captain then directs the pilot to hold his brakes while the chocks are removed.

25. After ensuring that all equipment is disconnected from the aircraft and moved out of the area, the plane captain directs the aircraft straight ahead out of the pit until it is safe to make a turn.

26. Electrical and electronic equipment may be reenergized when the aircraft is a safe distance from the pits.

AIRCRAFT DEFUELING PROCEDURES

The defueling procedures discussed in this training manual are for the A-6A aircraft only. Do not attempt to defuel any aircraft without carefully reviewing the procedures outlined in the technical manuals for each aircraft.

No radio or radar activity is permissible within 75 feet of the aircraft while defueling it. Ensure that the aircraft and defueling unit are grounded. Discharge any static electricity from the nozzle before attaching it to the pressure adapter in the same manner as required for fueling.

Defueling Fuselage Tanks

If there is an empty centerline stores drop tank or buddy tank aboard, it must be removed. The step-by-step procedures for defueling the fuselage tanks are as follows:

1. Check that the aircraft, fueling nozzle, and the defueling unit are grounded.
2. Open the pressure fueling adapter access door and remove the cap from the adapter.
3. Enter the nosewheel well and remove the access door located on the bulkhead aft of the nose gear. Reach through the access hole and manually open the fueling gate valve by its lever.
4. Manually close both wing gate valves.
5. Connect the pressure fueling nozzle to the adapter and start the defueling pump. If the pressure nozzle (Parker) has a manual lever, turn it to full open. Fuel will then flow from the fuselage tank until it is empty.
6. When defueling has been completed, remove the pressure fueling nozzle and close the access door. Replace the access door in the wheel well.

Emergency Defueling (All Tanks)

The outboard wing tanks cannot be emptied unless the wings are spread. The tanks are automatically defueled in the following sequence—drop tanks, wing tanks, and fuselage tank. The defueling sequence can be stopped at any point by placing the POWER switch on the fueling station control panel in the OFF position. EXAMPLE: If it is desired to perform maintenance on the outboard wing tanks, the drop tanks must be defueled before the outboard tanks. When the outboard wing tanks are empty, the sequence can be stopped by placing the POWER switch on the fueling station to the OFF position.

The step-by-step procedures for defueling all tanks are as follows:

1. Check that the aircraft, fueling nozzle, and the defueling unit are grounded.
2. In the cockpit the plane captain sets both ENGINE and FUEL MASTER switches to OFF; sets all radio and radar switches to OFF. On the fuel management panel he sets the WING, DUMP, FUS-DUMP, TANKS PRESS, and WING DROP TANK TRANS switches to NORM. He then depresses the FUEL GAGE WING button.
3. Open the fueling station and pressure adapter access doors.
4. Connect the external power supply to the aircraft.
5. In the right-hand wheel well, connect an external air source to the defueling air pressure connection.
6. At the fueling station control panel, place the POWER switch to DEFUEL. On the external power connection panel, set the WING GATE VALVE switch to OPEN.

7. Connect the pressure fueling nozzle to the adapter and start the defueling pump. If there is a manual lever on the pressure nozzle, it must be locked open. Fuel will flow from all wing drop tanks and centerline stores drop tank or buddy tank, and a small amount will also flow from the wing tanks. After the drop tanks are emptied, fuel will then flow from the wing tanks only.

8. The plane captain must monitor the fuel quantity gages and, when the wing fuel gage stops going down or reads 0, he must signal STOP DEFUEL and set the WING GATE VALVE switch to CLOSE. NOTE: After the wing tanks and drop tanks have been defueled the centerline stores drop tanks or the buddy tank must be removed from the aircraft or fuel will not flow properly from the fuselage tank.

9. After the wing tanks are empty, the fuel in the fuselage tank will automatically begin to flow until the fuselage tank is emptied.

10. After all tanks are empty, place the POWER switch on the fueling station control panel to OFF. Place the WING GATE VALVE switch to OPEN.

11. Remove the external air connection, external power, and the defueling nozzle. Close the access door on the fuel station control panel.

SAFETY PRECAUTIONS

Further detailed fueling and defueling procedures, equipment, description, and precautions are contained in Aircraft Refueling, NAVAIR 06-5-502.

Before either fueling, defueling, or purging is started, the OOD should be notified, permission received to commence, and the smoking lamp put out. At the end of the operation the OOD should be notified and the smoking lamp lighted. During planned flight quarters, fueling and defueling are expected and requesting permission to fuel and defuel from the OOD is not necessary, but he should be notified as to the recommended condition of the smoking lamp.

Care should be exercised to prevent the striking of sparks in locations where gasoline is being handled. Use only sparkproof tools.

The supervision of fueling, defueling, and purging operations should always be done by a petty officer to make sure that all safety precautions are carried out and that the operation is done properly.

All personnel involved in the handling of aviation fuels must be thoroughly trained in firefighting and made fully aware of the constant danger of fire and the everyday precautions that must be taken.

In case of equipment failure, shut down if necessary. Take all necessary precautions and procedures before continuing the operation.

If fueling or defueling is to be done when the ship is not at flight quarters, the necessary division should be notified to man the ship's firefighting equipment to take care of the situation in case of fire.

The petty officer in charge of the fueling crew checks with the plane captain or other authorized representative of the aircraft crew to ensure that, unless required in fueling (or defueling) operation or in the quantity gaging system check, no electrical equipment in the aircraft is energized or being worked on, and that no electrical apparatus supplied by outside power (electrical cords, droplights, floodlight, etc.) is in or near the aircraft. For night refueling or defueling, approved explosive-proof flashlights instead of aircraft lights are used.

Aviation fuel fires are class B fires and are fought with CO_2, foam, PKP, and light water. The equipments aboard ship are the standard foam nozzle (with quick-acting shutoff valve and stream shaper) and the 15-pound CO_2 bottle. Fog foam generators are a permanent installation aboard ship and are manned at any time fueling and defueling are being done. In case of a fire, notify the OOD immediately and take all the necessary steps to control it as much as possible until the fire party arrives. During flight quarters a salt water hose and two fog foam lines are laid out and charged from each fire station. The crash and salvage repair team is in charge of firefighting on the flight deck and V-3 on the hangar deck.

The fueling and defueling of aircraft are handled by the aviation fuels crew under the direction of the officer who is responsible for this procedure. The fueling and defueling of aircraft are to be performed only by members of an aviation fuels crew.

While the aircraft is being fueled or defueled, one of the aviation fuels crew with a portable carbon dioxide or dry chemical hand fire extinguisher must be stationed nearby.

In order to mop up or to spread any spilled fuel so that it will evaporate quickly, a member of the fueling crew must be standing by with a swab near the aircraft filling connection.

A nonsparking pail full of water should be readily available for rinsing the swab. After rinsing thoroughly, air the swab in an exposed location. DO NOT BRING A CONTAMINATED SWAB INTO AN ENCLOSED SPACE. Dump water used for ringing the swab overboard to leeward, taking care to keep clear of any openings in the ship's structure.

The following grounding procedure must be carried out each time that an aircraft is fueled:

1. Connect ground wire from aircraft to deck metal.

2. Connect ground wire from nozzle to aircraft.

3. Remove cap from filler connection and attach/insert nozzle.

4. When filling is completed, cut off nozzle, remove from aircraft, and replace the cap on the filler connection.

5. Disconnect ground wire from nozzle to aircraft.

6. Disconnect ground wire from aircraft to deck metal.

Leaks in aircraft, hose, connections, or trouble with fueling equipment should be reported immediately to the aviation fuels officer.

AIRCRAFT PURGING AND VENTILATION PROCEDURES

Air ventilation of the fuel tanks is mandatory in order to allow personnel to enter the tank for inspection or work purposes.

After the aircraft is defueled, all remaining residual fuel which cannot be withdrawn by defueling must be drained from the tanks by oepning all water drains. After all fuel has been removed in this manner, the tanks may be opened. Air ventilation procedures must be instituted immediately. This operation is very hazardous, as there is little control over the vapors released. Residual fuel which remains in the tank must be sponged or mopped up. The personnel doing the mopping up must wear air line hose masks to prevent inhalation of fuel vapors. Prior to conducting any work in the tank a test should be made to determine that a flammable vapor-air mixture, or toxic quantities of vapors are not present in the work area. There should be no operating radar equipment within 250 feet of the area where tank ventilation is being conducted. A Lamb air mover may be used to remove fuel from areas of the tank that are not accessible. The air mover, an eductor which operates on compressed air, must be grounded during operation.

As soon as the tank is opened, the air blower should be started to remove the air from the tank and tank area. Suction should always be taken from the tank and directed outside of the ship or area. CAUTION: High-pressure air must not be used to ventilate the tanks.

Although the maintenance personnel of the squadrons are generally responsible for the purging of aircraft fuel systems, the ABF may sometimes be called upon to perform this operation. Purging of the system may be done either with nitrogen (N_2) or with CO_2. The aircraft's fuel system manual will give the details on the procedure required for each aircraft. Purging is required for those aircraft undergoing hot work.

CHAPTER 12

ENVIRONMENTAL POLLUTION CONTROL

When it first began to dawn on people that the environment was worsening, that blight was creeping across our land, that the air was polluted and the waters running with waste, the Navy took steps to lessen its contribution to all the varieties of pollution. In the face of this challenge, Navy training and education must be broadened to include knowledge of how we affect our environment; thus, the inclusion of this chapter in this manual.

AIR POLLUTION

The contamination of the air with unwanted gases, smoke particles, and other substances is generally considered a recent phenomenon. However, pollution of the air, particularly with smoke, has plagued communities since the dawn of the Industrial Revolution. By the latter part of the 19th century complaints against air pollution were registered in Europe as well as in the United States. Records show that pollution control laws were adopted by Chicago and Cincinnati as early as 1881, and that by 1912, most American cities with populations over 200,000 had smoke abatement ordinances.

Although historical records do not offer any assurance that a significant amount of pollution was ever controlled under these laws, it was a beginning. These local control efforts were focused primarily on reducing smoke from fossil fuels, particularly coal, by regulating the types of coal that could be burned, by improving combustion practices, and, in some cases, by the application of special devices to control emissions of particles into the air.

During the 1940s, a new type of air pollution problem was emerging. When the citizens of Los Angeles began to complain of smog, few people suspected that the problem of smoke pollution and the general problem of air pollution are not the same. Los Angeles used virtually none of the fuels primarily responsible for the smoke problems of other cities; yet, the smog became worse. It was later discovered that the Los Angeles smog was not due primarily to smoke in the air but to the action of sunlight on certain of the gases emitted by car exhausts.

CLASSES OF POLLUTION

Five main classes of pollutants are pumped into the air over the United States, totaling more than 200 million tons per year.

Carbon Monoxide

Carbon monoxide is a colorless, odorless, poisonous gas, slightly lighter than air, that is produced by the incomplete burning of the carbon in fuels. Carbon monoxide emissions can be minimized by supplying enough air to ensure more complete combustion. When this happens, carbon dioxide, CO_2, a natural constituent of the atmosphere, is produced instead of carbon monoxide.

Almost two-thirds of the carbon monoxide in the air we breathe comes from internal combustion engines, and the overwhelming bulk of that comes from gasoline-powered motor vehicles. This is one of the most common pollutants, and when inhaled, it displaces the oxygen in the blood and reduces the amount of oxygen carried to the body's tissues. At levels commonly found in the air, it can affect the reactions of even the healthiest persons, making them more prone to illnesses.

Studies show that exposure to 10 parts carbon monoxide per million parts of air (ppm) for approximately 8 hours can affect a person's mental performance. Such levels of carbon monoxide are commonly found in cities throughout the world. In heavy traffic, levels of 70, 80, or 100 ppm are not uncommon.

Particulate Matter

Particulate matter includes particles of solid or liquid substances in a very wide range of sizes, from those that are visible as soot and smoke to particles too small to detect except under an electron microscope. Particulates may be so small that they remain in the air for long periods and can be transported great distances by the winds. They are produced primarily by stationary fuel combustion (31 percent) and industrial processes (27 percent). Forest fires and other miscellaneous sources account for 42 percent.

The lowest particulate levels at which health effects have been noted in the United States have been reported in studies at Buffalo, N.Y. The Buffalo findings suggest that the overall death rate increases in areas with an annual average concentration ranging from 80 to 100 micrograms per cubic meter. This study also reveals an association between these levels of particulate matter and gastric cancer in men 50 to 69 years old, and a similar association was found in a Nashville, Tenn., study. Particulate levels in this range are found in most major urban areas and are common even in smaller industrial cities.

A number of particulates present special health hazards. Beryllium, for example, which may be emitted from industrial sources and in smaller amounts from its use in rocket fuel, can cause lesions in the lung, leading to serious respiratory damage and even death.

Asbestos, long recognized as presenting an occupational hazard, is increasingly present in the air from its use in construction materials, brake linings, and other products. Long exposure produces the lung scarring disease asbestosis. On the other hand, heavy or continued exposures do not seem necessary to produce mesothelioma, a type of lung cancer associated almost exclusively with asbestos exposure.

A host of other particulates are of growing concern even though they may not constitute such an immediate and direct threat. For example, current studies suggest that lead levels now being found in the blood and urine of urban residents although below those associated with classic lead poisoning may affect the ability of the body to produce blood cells and have unsuspected adverse effects, particularly in children. As air pollution becomes more widespread, increasing numbers of people are being exposed to airborne lead, chiefly from car exhausts, at levels formerly found only in congested areas.

There are established techniques for controlling particulates from a boiler stack or from a waste air stream. Among them are filtering, washing, centrifugal separation, and electrostatic precipitation. These work well for most of the particles, but complete removal, especially of the very finest particles, is technically and economically difficult.

Sulfur Oxides

Sulfur oxides are acrid, corrosive, poisonous gases produced when fuel containing sulfur is burned. Electric utilities and industrial plants are its principal producers since their most abundant fuels are coal and oil, which contain sulfur as an impurity. The burning of coal produces about 60 percent of all sulfur oxide emissions, oil about 14 percent, and industrial processes that use sulfur, 22 percent. Most of the coal and oil is burned in electric power generation plants. About two-thirds of the nation's sulfur oxides are emitted in urban areas, where industry and population are concentrated.

These sulfur oxides can cause both temporary and permanent injury to the respiratory system. When sulfur oxides are inhaled along with particulate matter, the health damage increases significantly. Sulfur dioxide gas alone can irritate the upper respiratory tract. Health may be affected adversely when the annual mean concentration of sulfur dioxide in the air rises above 115 micrograms (.115 milligrams) per cubic meter (35.3 cubic feet). American cities often substantially exceed this annual mean.

Government agencies and industry have sought to reduce sulfur oxide emissions in three ways: switching to low sulfur fuels (those with less than 1-percent sulfur), removing sulfur from fuels entirely, and removing sulfur oxides from the combustion gases.

Hydrocarbons

Hydrocarbons, like carbon monoxide, represent unburned and wasted fuel. Unlike carbon monoxide, gaseous hydrocarbons at concentrations normally found in the atmosphere are not toxic, but they are major pollutants because of their role in forming photochemical smog. (Nitrogen oxides, when in the presence of sunlight, combine with gaseous hydrocarbons to form a complex variety of secondary pollutants called photochemical oxidants.) More than half the estimated 32 million tons of hydrocarbons produced each year comes from transportation sources, mainly gasoline-fueled vehicles. Another 27 percent comes from miscellaneous burning and 14 percent from industrial processes. About 60 percent is produced in urban areas, largely because there are more automobiles.

Nitrogen Oxides

Nitrogen oxides are produced when fuel is burned at very high temperatures. Stationary combustion plants produce 49 percent of the nitrogen oxide emissions, transportation vehicles 39 percent, and all other sources 12 percent.

Internal combustion engines operate at very high temperatures, and so do efficient, large electric power and industrial boilers. Nitrogen that is ordinarily inert combines with oxygen in high temperature flames and tends to stay combined if the exhaust gases are cooled too quickly. The control of nitrogen oxides from stationary sources requires careful adjustment of flames and stack gas temperatures. Control of nitrogen oxides from automobiles is more difficult because reducing other pollutants can increase the output of nitrogen oxides.

Under the influence of sunlight, nitrogen oxides combine with gaseous hydrocarbons to form a complex variety of secondary pollutants called photochemical oxidants. These oxidants, together with solid and liquid particles in the air, make up what is commonly known as smog. The photochemical oxidant family of pollutants can cause eye and lung irritation, damage to vegetation, offensive odor, and thick haze.

Reducing sulfur discharges from ships has proven to be a difficult job. Starting in 1967, the Navy developed a new type of fuel oil called Navy distillate fuel. This fuel reduces smoke and sulfur dioxide emissions very significantly. It is a clean burning fuel, and we are engaged in an intensive program to convert all conventionally powered ships to this new type of fuel.

CONTROLLING POLLUTION

In the United States there are a variety of Federal, state, and local programs aimed at combating air pollution. The first Federal program dealing with air pollution was created in 1955, when Congress enacted legislation authorizing Federal research into the problem while also giving technical assistance to state and local governments. This legislation established the Federal policy that state and local governments have a fundamental responsibility for dealing with community air pollution problems and that the Federal government has an obligation to provide leadership and support. This policy is still in effect, and all Federal air pollution programs are carried out by the National Air Pollution Control Administration (NAPCA).

In 1963 the U.S. Congress enacted the clean air act, which authorized two new major Federal activities to support air control efforts throughout the country. This act provided for the awarding of grants directly to state and local agencies to assist them in developing, or improving control programs. It also assigned the Federal government new responsibilities for the research on two important aspects of the national pollution problem, motor vehicle pollution and sulfur dioxide pollution. In addition, it gave the Federal government the responsibility of developing criteria to evaluate the effects of air pollution on health and property. In 1965 the clean air act was amended to enable the NAPCA to establish standards of motor vehicle pollution. Briefly, here is what the Navy has done to reduce pollution from crankcase and exhaust emissions.

During the combustion process in a gasoline engine, gases seep past the piston rings into the crankcase. These cases are the result of burned and unburned fuel and oil in the combustion chamber. The seepage, called blowby, moving past the rings is the result of:

1. High combustion chamber pressures.
2. Necessary working clearances of piston rings in their grooves.
3. Normal ring shifting that sometimes lines up clearance gaps of two or more rings.

If blowby is not removed from the crankcase, it condenses in the crankcase to form sludge and to cause oil dilution.

In 1963, the Positive Crankcase Ventilation (PCV) system was introduced on all newly manufactured cars. However, this system had been used on military vehicles long before this to combat sludge problems. The first systems used the OPEN PCV system. This system uses manifold vacuum for its vacuum source. Fresh air enters an open PCV system through a vented oil filler cap, mixes with the crankcase vapors in the crankcase, and is metered through a PCV valve into the intake manifold. Here it blends with the fuel air mixture being delivered by the carburetor to be burned in the combustion chamber.

Starting in 1968, all new cars and trucks have been equipped with the CLOSED PCV system. The closed PCV system is similar in operating principle to the open system except that fresh air enters the closed system from the clean air side of the air cleaner or a separate PCV breather filter on the inside periphery of the air cleaner.

Most open and closed systems normally use a PCV valve. However, some installations use a fixed orifice instead of a valve. In some instances, the metering orifice is in the oil filler cap. In these systems, the air flow in the PCV system is not regulated, but only restricted. This is referred to as the tube-type ventilation system. Regulation of the air fuel ratio is accomplished through carburetion alone, since the orifice size is fixed and cannot be varied during operation.

The detailed operation of these systems is covered in the Third and Second Class Rate Training Manuals for AS and CM.

Excessive (visible) exhaust emissions are due primarily to incomplete combustion in the combustion chamber. The automobile manufacturers use different means to control these emissions and likewise use different general terms to identify their systems.

During deceleration the fuel air ratio is very rich in the area of the exhaust valve. If the air pump system were allowed to operate under this condition, back-firing conditions would result as soon as the fresh air from the pump mixed with overly rich vapor to produce a combustible mixture. A vacuum-operated diverter valve (bypass valve) prevents this by dumping air pump output into the atmosphere during the deceleration period. (Some installations divert the air pump output directly back to the air pump itself.)

In addition to, or substituting for the air pump, most cars manufactured beginning in 1968 used modified carburetion (resulting in cleaner fuel air ratios), revised ignition timing, and hotter thermostats.

Motor vehicle pollution is the product of a complex combustion system of engines, fuels, and fuel additives. Effective control, then, means dealing not only with engines and control devices but with the fuel itself and with fuel additives.

Air injection was the first step toward the control of exhaust emissions. This is commonly referred to as an AIR PUMP system. It was first used in 1966 and 1967 on some cars and, beginning in 1968, was rather widely used on many cars. The following is a trade description of the air pump as offered by some manufacturers.

The system consists of an air pump, air manifold, check valve, and diverter valve. Most pumps use a relief valve in the side of the pump housing which relieves the pressure built up in the pump if it exceeds a pre-determined value.

In operation, compressed air from the pump is distributed through a manifold to the pipe extension or jet behind each exhaust valve. The injection of air at this point causes those unburned fuel and oil particles and other by-products of combustion to burn in the exhaust manifold as they leave the cylinder head rather than pass out to the atmosphere through the exhaust pipe.

The check valve prevents exhaust gases from entering the pump should pump or drive belt failure occur.

The key undesirable additive from an air pollution control view point is tetraethyl lead in gasoline. It accounts for a significant portion of the particulate pollution from automobiles. Some gasoline manufacturers are producing gasoline that is almost lead-free. However, some premium gasolines containing lead will still be needed for a number of years to meet the requirements of high compression engines in older cars.

Jet engines also contribute their share of pollutants to the air. Present Navy efforts toward reduction of air pollution by jet engines are being directed along two channels: (1) improvement of engines and (2) removal of particulate matter from engine test cell exhausts.

To date, the Navy has spent money on development of smokeless combustors and the retrofitting of new combustor cans in certain engines. Replacement of combustor cans in the TF-30-P-8 and J52-P-8 engines has been completed. More money and effort will be spent to develop acceptable designs and prototypes to eliminate smoke from the TF 41, TF 30-P-6, T56, J79 and J57 models.

New naval aircraft engines will be equipped with smokeless combustors. These are the F14, S3 and engines for new heavy-lift helicopters.

It is expected that, by 1976 or 1977, all naval combat aircraft will be equipped with smokeless combustors and will comply with regulations on visible emissions.

Studies have been made of several systems for controlling emissions from jet engine test cells. A system called a "nucleation scrubber" or wet scrubber facility seems promising. It is expected to remove 99 percent of the noxious gases from engine test cell emissions.

The Navy, with the cooperation of Pratt and Whitney, has carefully evaluated the use of fuel additives, including Ethyl "CI-2", both in engine test cells and in flight. Tests have indicated degradation of engine performance and in some cases compressor stalls, a very unacceptable condition. Use of this additive has also resulted in deposits of hard residues on surfaces of internal engine parts, significantly increasing maintenance.

WATER POLLUTION

There are several Federal laws governing air and water quality standards, when they must be achieved, and punishments for violations. In conjunction with these laws there are several Navy instructions concerning procedures to be followed by ships and shore installations to abate pollution of the environment in general, and of waters in particular. Several basic, biological, chemical, and physical processes affect the quality of water. Since in this text we can only generalize, we will place water pollution into two categories: organic waste, and oil.

ORGANIC WASTE

Organic wastes (natural products such as food, paper, human waste) decompose by bacterial action. Bacteria attack wastes dumped into rivers and lakes, using up oxygen in the process. Fish and other aquatic life need oxygen. If the waste loads are so great that large amounts of oxygen are spent in their decomposition, certain types of fish can no longer live in that body of water. A pollution-resistant lower order of fish, such as carp, replace the original fish population. The amount of oxygen in a water body is therefore one of the best measures of its ecological health.

If all the oxygen is used, an anaerobic (without air) decomposition process is set in motion with a different mixture of bacteria. Rather than releasing carbon dioxide in the decomposition process, anaerobic decomposition releases methane or hydrogen sulfide. In these highly polluted situations, the river turns dark, and odors—like rotten eggs—penetrate the environment.

Heated water discharged into lakes and rivers often harms aquatic life. Heat accelerates biological and chemical processes, which reduce the ability of a body of water to retain dissolved oxygen and other dissolved gases. Increases in temperature often disrupt the reproduction cycles of fish. By hastening biological processes, heat accelerates the growth of aquatic plants—often algae. Finally, the temperature level determines the types of fish and other aquatic life that can live in any particular body of water. Taken together, these effects of excess heat operate to change the ecology of an area—sometimes drastically and rapidly.

One of the most serious water pollution problems is eutrophication—the "dying of lakes." All lakes go through a natural cycle of eutrophication, but normally it takes thousands of years. In the first stage lakes are deep and have little biological life. Lake Superior is a good example. Over time, nutrients and sediments are added; the lake becomes more biologically productive and shallower. This stage has been reached by Lake Ontario. As nutrients continue to be added, large algal blooms grow, fish populations change, and the lake begins to take on undesirable characteristics. Lake Erie is now in this stage. Over time, the lake becomes a swamp and finally a land area.

Man greatly accelerates this process of eutrophication when he adds nutrients to the water—detergents, waste food products, fertilizers, and human wastes. He has done this in Lake Erie and countless other lakes. Man's action can, in decades, cause changes that would take nature thousands of years.

We've mentioned above the harmful effects of polluted waters on the natural environment, but what about water pollution's effect on human health?

Epidemics of typhoid, dysentery, and salmonellosis borne by polluted water are no longer serious public health threats in the United States. However, to maintain adequate protection of the public from these and other pollution dangers, water must often be treated to high levels before it is drinkable. Beaches often must be closed and shellfish left unharvested and unmarketed. Inadequately disinfected municipal wastes, overflows from combined sewer systems, and runoff from animal feedlots often create high bacteria densities in local water supplies. Ships that are anchored far up-stream can contribute to a high bacteria count in a community's water supply. The Navy is exploring the use of many devices and schemes to lessen the effect of waste discharges on water. Some of them are discussed in the following paragraphs.

Because there have been no constraints on the quality of effluent (nutrients, etc) in the past, optimum damage resistance and minimum cost design for Navy ships dictated a minimum penetration of water tight bulkheads and decks. This led to direct overboard discharge of all waste drains and soil drains into rivers, bays, estuaries, and the high seas at the nearest point of approach of the hull plating from the head or washrooms. Carriers, for example, have as many as 150 discharge hull penetrations.

The Water Quality Improvement Act of 1970, PL 91-224, dated 3 April 1970, stipulates that the environmental protection agency would set the sewage system effluent standards. This law also stipulates that existing ships including those under construction would have to be backfitted within five years after the sewage system effluent standards were promulgated. Ships constructed after this date must meet the standards within 2 years.

The Navy has funded research and development on Marine sanitation devices. These are: (1) Aerobic Systems, (2) the Macerator Chlorinator, (3) the Recirculation Flush-sludge Storage System, (4) 175 Man Fairbanks-Morse System, and (5) the 500 Man Fairbanks-Morse System.

Aerobic systems for shipboard use have not been successful, and the Navy terminated this effort several years ago. Both the Coast Guard and the EPA also terminated further development of these basically small extended aeration biological systems for shipboard use.

The Macerator-Chlorinator system merely grinds the solids into small particles and mixes the raw sewage with hypochlorite and some chemical reaction occurs to reduce biochemical oxygen demand (a measure of the amount of oxygen needed to decompose wastes), and most of the organisms are destroyed. This unit is simple to install and operate and is lowest in cost, weight and space problem. Until satisfactory second generation devices are available, the Navy is recommending that EPA consider this device for ships, boats, and service craft having personnel of up to 50.

The Recirculation system uses water to circulate the solid sludge to a holding tank where the water is removed and the concentrated sludge is stored. This system is similar to that used on commercial aircraft. The water is treated by chemicals and is recirculated in the system. The concentrated sludge is cleaned out when the ship is at sea or is connected to a shore sewage line. It is simple, low cost and requires low space and weight for installation. However, holding capacity is limited and this places a constraint on ship operations. One manufacturer of a system of this type is developing an incinerator to burn the sludge.

With all this effort and time, the Navy has yet to develop what can be considered a system that has proven reliable, maintainable and safe. Obviously, ship sewage disposal is the most difficult Navy problem to solve. Currently, we have 24 different proposals under evaluation and are encountering problems of performance and equipment reliability. The Navy must be absolutely certain that a completely reliable system is available before we start installing equipment on 700 naval ships at a cost now estimated to exceed $300 million.

OIL POLLUTANTS

Oil is probably the most obvious physical pollutant. Oil spills as a result of collisions or other types of overboard discharges put a coating on everything touched. Oil makes beaches unusable during costly cleanup operations; it fouls boat hulls, pier pilings, and shore structures, and it degrades the esthetic nature of the environment.

The Navy's problems are not those generally caused by massive oil spills–but by the pernicious small spills in harbors which are caused by leaks in systems; overflows through vent pipes on ships, fuel line parting during oil transfers and recovering operations; and human errors. Cleaning up oil spills is time consuming, difficult, costly and often results in claims against the Government. Also, such spills create a serious fire hazard, are harmful to fish, shellfish and wild life; cause damage to watercraft; deny unrestricted use of bathing beaches and other private property; can contaminate water supply systems; and be aesthetically displeasing.

This oil spill problem became acute with the signing of "The Water Quality Improvement Act of 1970" where the Congress declared "That it is the policy of the United States that there should be no discharge of oil into or upon the navigable waters of the United States, adjoining shorelines, or into or upon the waters of the contiguous zone, i.e., except those quantities as determined by the President."

The President through his enforcement agency, the Environmental Protection Agency (EPA), has established regulations which prohibit oil spills which "cause a film or sheen upon or discoloration of the surface of the water of adjoining shorelines or cause a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines."

PREVENTIVE MEASURES

The Navy's oil pollution abatement problem and solutions are being approached in several directions. Fleet commanders, Sea Frontier commanders and Commandants have an active program to re-evaluate existing operational procedures.

Education, increasing training measures with relation to oil problems, and better preventive maintenance techniques, both ashore and afloat, are contributing a marked reduction in oil spills.

Containment of Oil at Source

To this end the Navy is programming the procurement of thousands of feet of oil booms for containing oils close to the source of spill. The Naval Research Laboratory in Washington, D. C. is studying how to control and confine oil spills using surface films. There are a series of organic chemicals which form very thin surface films (monomolecular layers) capable of driving oil across a water surface, increasing the oil-layer thickness, and reducing its area of coverage. A thicker oil layer occupying a smaller water surface area simplifies any recovery operation. More importantly the surface films can be used to prevent spreading of an oil spill; chemical boom effect. The oil-control films are largely insoluble in both oil and water and spread into extremely thin layers, usually only one molecule thick. Consequently, small quantities can cover large water surface areas and provide oil control and confinement.

Current research is directed toward the selection of ideal materials for this application which are nontoxic and acceptable to the Environmental Protection Agency for use in rivers, harbors and estuaries.

Removal or Recovery of Oil From Within the Containment Area

The Navy policy is to physically remove oil from waters and to restrict the use of chemical emulsifiers, dispersants, and sinking agents, primarily to incidents which reduce hazard to human life or where there is substantial hazard of fire to property. Realizing that oil spills will inevitably occur in spite of our best efforts, the Navy is establishing at each of its major naval ports an "in house" rapid response capability to clean up moderate oil spills emanating from naval vessels or shore facilities. At most naval facilities this capability will team up with contractors, other federal agencies or join into municipal or industrial oil removal coops. In an effort to provide adequate equipment to do the job, the Navy has embarked on a Joint Funded Demonstration project for an oil skimming device with the Environmental Protection Division. The skimmer employs the inverted weir principle which takes advantage of the buoyant properties of oil. The oil is carried under the skimmer device and is captured in a chamber, essentially water free, for removal to storage areas.

Another promising device consists of a rotating multidisc drum that looks somewhat like a harrow as it turns in the water. As the drum passes over the oil and water, the oil adheres to the rotating discs. A wiping device cleans the disc and sends the oil through a collection pipe to a storage area.

Oil Spill on the High Seas

We are all familiar with the massive oil spill problem associated with the Torroy Canyon tanker casualty off the coast of England and the Olean Eagle off San Juan, Puerto Rico. These accidents have generated national and international concern over the technical and managerial aspects of the problem.

The primary responsibility for mobilizing personnel and material resources against such major hazards rests with U.S. Coast Guard, Department of Transportation and the FWQA, Department of Interior. However, the recognized capability of the Navy to operate widely and diversely in the sea environment makes it natural for naval forces to be called upon to assist in these major oil pollution catastrophies.

The deliberate pollution of the high seas by petroleum and petroleum products is causing concern to all nations of the world. To this end the NATO Committee on the Challenges to Modern Society met in Brussels to develop action resolutions to combat pollution of the sea by oil spills. As of now all ships, in particular tankers, are permitted to dump ballast and bilge water into the high seas. The committee developed Navy resolutions which will have a major impact on the operation of vessels on the high seas in the near future.

The President stated in his message to the Congress of 20 May 1970 that the threat of oil pollution from ships at sea and in harbors represented a growing danger to our marine environment and any remedy must deal with this problem on a global basis. To initiate impetus for effective international cooperation in alleviating the threat of oil spills on open waters, and to demonstrate the highest level of interest, the President appointed the Secretary of Transportation as Chairman of the U.S. Delegation represented at the November 1970 NATO Committee on Challenges of Modern Society (CCMS) Oil Spill Conference in Brussels. The Secretary of Transportation in his address to the Conference stated that "The United States. . .is fully committed to a priority national policy of improving and safeguarding environmental quality. Few problems in this field are so pressing or so readily evident as those posed by ocean oil pollution . . My government proposes that NATO nations resolve to achieve by mid-decade a complete halt to all intentional discharges of oil and oily wastes into the oceans by tankers and other vessels. This is a fundamental and major goal; it may involve steps such as improved ship design aimed at clean ballast operations and the development of adequate port facilities to receive waste, oily bilge, and ballast waters." The nations of NATO adopted this position in slightly modified tone as one of their major goals. In order for the Navy to respond effectively to this formidable task requested by the Administration and to demonstrate continued Navy leadership in the field of pollution abatement, the Navy initiated a survey of existing Naval Shore Facilities and ships to determine the following:

1. The current capability and capacity for handling, processing, reclaiming and/or disposing of bilge and ballast oily wastes from U.S. Naval vessels which will be required by mid-decade.
2. Needed repairs and alterations in shore facilities and operating practices for the receipt, storage, issue, and handling of petroleum products, to prevent leakage and accidental discharge to the environment.
3. Required repairs and alterations to naval ship systems, equipment, and procedures for storing and/or handling oily mixtures while underway to prevent discharge to the ocean environment.

Based on this effort the total requirements and costs to meet these new pollution abatement commitments will be integrated into a phased and orderly plan for early programming, budgeting, and implementation.

Navy Goals For Prevention of Water Pollution

The Navy's major goal by 1975, and not later than the end of this decade, is the complete halt of all discharges of oil and oily wastes into streams, harbors, and oceans by naval shore activities and vessels. Therefore, the use, storage, handling, and disposal of all materials, including but not limited to fuels, ashes, petroleum products, and other chemical and biological agents, shall be carried out to minimize the pollution of waters, land, and air.

In accordance with existing NAVOP Instructions, the Navy will develop Contingency Plans for implementing the National Oil and Hazardous Substances Pollution Contingency Plan (NOHSPCP) of August 1971. To better understand the terminology used in the development of these Contingency Plans, the following definitions are given.

1. Navigable Waters. Navigable waters of the United States include the coastal territorial waters (sea) of the United States, the inland waters of the United States including the U.S. portion of the Great Lakes and the St. Lawrence Seaway and the Panama Canal.

2. Coastal Territorial Waters. The coastal territorial waters (sea) extend to three miles seaward from the United States coastline.

3. Inland Waters. Inland waters are, generally, navigable fresh and/or brackish waters upstream from the coastal territorial waters.

4. Contiguous Zone. Defined in Article 24 of the Convention on the Territorial Sea and the Contiguous Zone as extending twelve miles from the baseline from which the territorial sea is measured.

5. Oil Spills

a. Minor Spill. A minor spill is a discharge of oil of less than 1,000 gallons in inland waters, or less than 10,000 gallons in coastal waters, or discharge of any material in a quantity that does not pose a threat to the public health or welfare. Discharges that (a) occur in or endanger critical water areas, (b) generate critical public concern, (c) become the focus of an enforcement action, or (d) pose a threat to public health or welfare, should be classified as a medium or major spill depending upon their degree of impact.

b. Medium Spill. A medium spill is a discharge of oil of 1,000 gallons to 10,000 gallons in inland waters or 10,000 to 100,000 gallons in coastal waters, or a discharge of any quantity of any material that poses a threat to the public health or welfare.

c. Major Spill. A major spill is a discharge of oil of more than 10,000 gallons in inland waters or more than 100,000 gallons in coastal waters, or a discharge of any quantity of material or substance that substantially threatens the public health or welfare, or generates wide public interest.

NOTE: All oil spills that produce a visible sheen in U.S. navigable waters and the contiguous zone must be reported immediately to the Commander of the local Coast Guard District, the Regional office, EPA, and to the U.S. Navy Area Coordinator in accordance with procedures outlined in current OPNAV Instructions.

6. Hazardous Substances. Hazardous substances are any element, compound, or isomersion or mixture, as designated in 18 CFR (Code of Federal Regulations) 618, that may pose an imminent or substantial danger to the public health or welfare when discharged into navigable waters of the U.S.

7. Discharge. Discharge includes, but is not limited to, any spilling, leaking, pumping, pouring, emitting, emptying, or dumping.

8. Public Health or Welfare. Public health or welfare includes consideration of all factors affecting the health and welfare of man, including, but not limited to, human health, the natural environment, fish, shellfish, wildlife, and public and private property, shorelines, and beaches.

RESPONSIBILITIES AND GUIDELINES FOR CARRYING OUT THE OIL AND HAZARDOUS POLLUTING SUBSTANCE SPILL CONTAINMENT AND REMOVAL PROGRAM

INTRODUCTION

The responsibility for the cleanup of oil and hazardous polluting substances occuring incident to world-wide naval operations lies with the Area Coordinators, Fleet Commanders-in-Chief, and the Major Claimants. This responsibility is to be discharged in accordance with plans developed in consonance with the National Oil and Hazardous Substances Pollution Contingency Plan of August 1971.

The Chief of Naval Material provides the technical expertise, materials and equipment to Area Coordinators and Fleet Commanders-in-Chief, as requested. Additionally, the Chief of Naval Material is responsible for the continued development of materials, equipment, and techniques for the mitigation, containment, and removal of oil and hazardous polluting substances from water, for the promulgation of materials and equipment specifications for use by Area Coordinators and Fleet Commanders-in-Chief, for the development of training mechanisms to assist the Area Coordinators and Fleet Commanders-in-Chief in combating spills, and for the central procurement of equipments and materials for Navy activities, particularly during initial outfitting.

Since spills of oil and hazardous polluting substances in inland waters require basically different technologies and approaches to cleanup from those occurring in coastal waters, the high seas or incident to salvage evolutions, a division of responsibilities is established within the Naval Material Command to best take advantage of the existing technical capabilities in the Naval Facilities Engineering Command (NAVFAC), and Supervisor of Salvage (SUPSALV), Naval Sea Systems Command (NAVSEA). Support to Area Coordinators and Fleet Commanders will be provided by NAVFAC on spills occurring in inland waters, harbors, and ports. NAVSEA (SUPSALV) will provide support for spills occurring in coastal waters, territorial seas, the high seas, or incident to salvage evolutions.

To provide a better understanding of the terminology used in implementing this program, the following explanations, definitions, and/or responsibilities are provided.

1. Area Coordinator (AC). The Area Coordinator (AC) is an executive agent predesignated by regional plan to coordinate and implement the development of effective and comprehensive contingency plans for naval activities, or complexes, as appropriate within their areas. Contingency plans should include provision for cooperation and coordination with appropriate organizations in contiguous foreign countries. These plans shall cover spill quantities up to and including major spills. The Area Coordinator predesignates the Navy on-scene coordinators for spills of oil and hazardous substances from naval activities within their areas of cognizance and for Navy spills within the contiguous zone, and for any Navy spill which threatens the coastline within the area of cognizance. He also designates the Navy representatives to the Regional Response Team.

2. On-scene Coordinator (OSC). The OSC is a single, executive agent predesignated by regional plan to coordinate and direct Federal pollution control efforts at the scene of a spill or potential spill in accordance with Section 306.2 of the National Oil and Hazardous Substances Pollution Contingency Plan.

3. Navy On-scene Coordinator (NOSC). The NOSC is a single Navy officer predesignated by the responsible Fleet Commander-in-Chief or Area Coordinator to coordinate and direct Navy pollution control efforts at the scene of a spill or potential spill. The NOSC is in command of response operations until such time when response actions are relinquished to the OSC. The NOSC is in charge of naval response operations at all times.

4. Navy Response Center (Command Post). This command post is established by the Navy Area Coordinator and located within his district. It is the Navy headquarters site for activities relative to pollutant spills. It is to be activated during serious spill situations and provide communications, information, a base of operations, and a command center to promote smooth and adequate response.

5. Response Modes. Response modes are established to indicate various levels of response, notification, and reporting, depending on the seriousness of the spill.

a. Routine Response. Routine responses are the lowest level of response. A spill incident where an existing local oil spill cleanup capability is activated (in-house and/or contract) and effectively copes with the spill. Notification of spill and/or situation reports are made only to local level commands and authorities as routinely required, usually after response actions are completed.

b. Standby Response. This response is for spill incidents, when the respondent determines on his first assessment of the spill that it may be beyond existing capabilities. The Navy On-scene Coordinator and principals involved in activating the Navy Response Center are notified of the spill incident and are advised of the standby response status for activating the Navy Response Center pending further on-scene evaluation of the spill situation.

c. Serious Spill Response. The Navy Response Center is activated when a spill incident poses a serious threat, is beyond control of existing cleanup capability, or for other reasons requires the highest level of response. It is assumed that Navy assistance beyond the local area may be requested from SUPSALV as well as the U.S. Coast Guard, EPA, and other non-Navy capabilities. The highest levels of command will be notified of the situation and response actions.

SHIP REGULATIONS

Trash and Rubbish

No trash and rubbish shall be thrown overboard within the "prohibited zone", which for most places is 50 miles from the coastline. Garbage shall not be thrown overboard within 12 miles of the contiguous zone which is 12 miles from the coastline. All trash and rubbish disposed at sea should be packaged to have negative buoyancy. These requirements shall not preclude the dumping of waste products when an emergency situation exists and failure to do so would clearly endanger the health or safety of personnel.

Overboard Discharges

The discharges to the sea or other waters of oils, oily wastes, sludges, industrial wastes, garbage, trash, or other refuse collected ashore or from ships in port is prohibited.

Fueling, Defueling, and Internal Fuel Transfer Evolutions

These evolutions should be accomplished to meet operational requirements with due consideration for economy of efforts and resources and not for opportunities of convenience. Such evolutions should be accomplished during daylight normal working hours, when operating schedules permit, by established and well-trained fueling details. Fueling Bills should make provisions for:

1. Topside watches at all locations of possible fuel spills with direct communication to fuel transfer stations.
2. Establishment of check-off lists and procedures for fueling system line-up and operation. Double-checking of all fueling system valves is absolutely essential.
3. Assurance that each member of the fueling detail is qualified in fueling procedures.
4. Continuous sounding of all tanks being filled.
5. Precautionary measures to minimize the danger of a fuel spill, should one occur, including blocked scuppers, adequate manpower, and sufficient material.
6. Certification to the commanding officer, command duty officer, or officer of the day, and fuel supplier that the ship is ready, in all respects, to commence fueling operations.

Prior to receiving fuel, the receiving ship should receive notification from the fuel supplier that the fueling equipment, fittings, and hoses have been tested and are in proper working condition in accordance with appropriate NAVSEA, NAVSUP and/or Marine Terminal regulations and instructions.

NOTE: Oil disposal in port will be accomplished by using modified piping systems and oil/water separators as modifications are completed and equipment installed. Until that time sludge barges and donuts will be employed.

APPENDIX I

THE METRIC SYSTEM

The metric system was developed by French scientists in 1790 and was specifically designed to be an easily used system of weights and measures to benefit science, industry, and commerce. The metric system is calculated entirely in powers of 10, so one need not work with the various mathematical bases used with the English system, such as 12 inches to a foot, 3 feet to a yard, and 5280 feet to a mile.

The system is based on the "meter" which is one ten-millionth of the distance from the Equator to the North Pole. It is possible to develop worldwide standards from this base of measurement. The metric system of weights is based on the gram, which is the weight of a specific quantity of water.

Soon after the system was developed scientists over the world adopted it and were able to deal with the mathematics of their experiments more easily. The data and particulars of their work could be understood by other scientists anywhere in the world. During the early 19th century many European nations adopted the new system for engineering and commerce. It was possible for these countries to trade manufactured goods with one another without worrying whether it would be possible to repair machinery from another country without also buying special wrenches and measuring tools. Countries could buy and sell machine tools and other sophisticated and precision machinery without troublesome modifications or alterations. It was much easier to teach the metric system, since meters can be changed to kilometers or centimeters with the movement of a decimal point, which is roughly like being able to convert yards to miles or inches by adding zeros and a decimal instead of multiplying by 1760 or dividing by 36.

With the exception of the United States, all the industrialized nations of the world have adopted the metric system. Even England and Canada are changing from their traditional systems of measure, and the metric system will be almost universal by 1980.

Although the metric system has not been officially legislated by the Congress, the metric system is becoming more prominent in this country. Most automobile mechanics own some metric wrenches to work on foreign cars or foreign components in American cars. Almost all photographic equipment is built to metric standards. Chemicals and drugs are usually sold in metric quantities, and "calorie counters" are using a metric unit of thermal energy.

Because we are allied with countries who use the metric system, much of our military information is in metric terms. Military maps use meters and kilometers instead of miles, and many weapons are in metric sizes, such as 7.62 mm, 20 mm, 40 mm, 75 mm, and 155 mm. Interchange of military equipment has caused a mixture of metric and English measure equipment since World War I when the army adopted the French 75 mm field gun, and World War II when the Navy procured the Swedish 40 mm Bofors and the Swiss 20 mm Oerlikon heavy machine guns.

It is inevitable that the United States will officially adopt the metric system. Exactly when this happens and how rapidly the changeover will depend on economics, since the expense of retooling our industry and commerce to new measurements will be very great. The cost of conversion will be offset by increased earnings from selling machinery and products overseas. Another benefit is that scientists use the metric system, but their calculations now have to be translated into English measure to be used by industry. With adoption of the metric system ideas can go directly from the drawing board to the assembly line.

The Navy will be using the metric system more during the next few years. Although you will find it easier to solve problems using this system, at first you will find it difficult to visualize or to estimate quantities in unfamiliar units of measure.

Fortunately, many metric units can be related to equivalent units in the English system.

The meter which is the basic unit is approximately one-tenth longer than a yard.

The basic unit of volume, the liter, is approximately one quart. The gram is the weight of a cubic centimeter, or milliliter, of pure water and is the basic unit of weight. As a common weight though, the kilogram, or kilo, which equals the weight of a liter of water, weighs 2.2 pounds. The cubic centimeter (cc) is used where we would use the square inch, and where we measure by the fluid ounce, the metric system employs the milliliter (ml). For power measure the metric system uses the kilowatt (kW), which is approximately 1.3 horsepower.

In terms of distance, a land mile is eight-fifths of a kilometer and a nautical mile is 1.852 kilometers, or nearly 2 kilometers.

A basic metric expression of pressure is the kilogram per square centimeter, which is 14.2 psi, nearly 1 atmosphere of pressure.

When working on foreign machinery, you may notice that your half-inch, three-quarter inch, and one-inch wrenches will fit many of the bolts. These sizes correspond to 13 mm, 19 mm, and 26 mm respectively in the metric system, and are very popular because they are interchangeable. The 13/16-inch spark plug wrench, which is standard in this country, is intended to fit a 20 mm nut.

The basic quantities of the metric system are multiplied or divided by powers of 10 to give other workable values. We cannot easily measure machine parts in terms of a meter, so the millimeter, or one-thousandth of a meter is used. For very fine measure the micron, also called the micrometer, can be used. It is one-millionth part of a meter, or one-thousandth of a millimeter. For small weights the milligram, one-thousandth of a gram is used. All of these multiples are expressed with standard prefixes taken from Latin:

micro	= 1/1,000,000
milli	= 1/1,000
centi	= 1/100
*deci	= 1/10
*deca	= 10
*hecto	= 100
kilo	= 1,000
*myria	= 10,000
mega	= 1,000,000

* Rarely used

Over the next few years the metric system will become more used by the Navy as well as by the civilian world. You will find it easy to work with once you have mastered the basic terms. It will be difficult to translate values from our present system to the metric system, but this operation will become unnecessary once the new measurements are totally adopted.

Tables of equivalent English measure and metric equivalents are essential when you work simultaneously with both systems. The table which follows shows the equivalent measures of the two systems. The columns on the left have the equivalent values which are accurate enough for most work, and on the right are the multiples used to convert the values with a high degree of accuracy.

Appendix I–THE METRIC SYSTEM

ENGLISH AND METRIC SYSTEM UNITS OF MEASUREMENT

COMMON EQUIVALENTS AND CONVERSIONS

Approximate Common Equivalents		Conversions Accurate to Parts Per Million (units stated in abbreviated form)	
		Number X Factor	
1 inch	= 25 millimeters	in X 25.4*	= mm
1 foot	= 0.3 meter	ft X 0.3048*	= m
1 yard	= 0.9 meter	yd X 0.9144*	= m
1 mile†	= 1.6 kilometers	mi X 1.60934	= km
1 square inch	= 6.5 square centimeters	in^2 X 6.4516*	= cm^2
1 square foot	= 0.09 square meter	ft^2 X 0.0929030	= m^2
1 square yard	= 0.8 square meter	yd^2 X 0.836127	= m^2
1 acre	= 0.4 hectare	acres X 0.404686	= ha
1 cubic inch	= 16 cubic centimeters	in^3 X 16.3871	= cm^3
1 cubic foot	= 0.03 cubic meter	ft^3 X 0.0283168	= m^3
1 cubic yard	= 0.8 cubic meter	yd^3 X 0.764555	= m^3
1 quart (lq.)	= 1 liter	qt (lq.) X 0.946353	= l
1 gallon	= 0.004 cubic meter	gal X 0.00378541	= m^3
1 ounce (avdp)	= 28 grams	oz (avdp) X 28.3495	= g
1 pound (avdp)	= 0.45 kilogram	lb (avdp) X 0.453592	= kg
1 horsepower	= 0.75 kilowatt	hp X 0.745700	= kW
1 pound per square inch	= 0.07 kilogram per square centimeter	psi X 0.0703224	= kg/cm^2
1 millimeter	= 0.04 inch	mm X 0.0393701	= in
1 meter	= 3.3 feet	m X 3.28084	= ft
1 meter	= 1.1 yards	m X 1.09361	= yd
1 kilometer	= 0.6 mile	km X 0.621371	= mi
1 square centimeter	= 0.16 square inch	cm^2 X 0.155000	= in^2
1 square meter	= 11 square feet	m^2 X 10.7639	= ft^2
1 square meter	= 1.2 square yards	m^2 X 1.19599	= yd^2
1 hectare	= 2.5 acres	ha X 2.47105	= acres
1 cubic centimeter	= 0.06 cubic inch	cm^3 X 0.0610237	= in^3
1 cubic meter	= 35 cubic feet	m^3 X 35.3147	= ft^3
1 cubic meter	= 1.3 cubic yards	m^3 X 1.30795	= yd^3
1 liter	= 1 quart (lq.)	l X 1.05669	= qt (lq.)
1 cubic meter	= 250 gallons	m^3 X 264.172	= gal
1 gram	= 0.035 ounces (avdp)	g X 0.0352740	= oz (avdp)
1 kilogram	= 2.2 pounds (avdp)	kg X 2.20462	= lb (avdp)
1 kilowatt	= 1.3 horsepower	kW X 1.34102	= hp
1 kilogram per square centimeter	= 14.2 pounds per square inch	kg/cm^2 X 14.223226	= psi

†nautical mile = 1.852 kilometers

* exact

APPENDIX II

GLOSSARY

ABRASION. The condition of wear.

AEROBIC. A microorganism that can live and grow only where free oxygen is present.

AFFINITY. A close relationship; connection.

AMPLIFIER. An instrument used for strengthening electrical impulses.

APA. Appropriation Purchases Account.

BELLOWS. A device used for producing a stream of air.

BERYLLIUM. A hard rare metallic chemical element.

CALIBRATION. To check, fix, or correct the graduation of a measuring instrument.

CAPACITOR. An electric condenser.

CARBON DIOXIDE (CO_2). A gas used to protect against fire in AvGas and JP-5 systems aboard ships.

CARBON MONOXIDE. A colorless, odorless, poisonous gas.

CENTRIFUGAL. Moving or tending to move away from the center.

CLEAVAGE. The manner in which a thing splits.

COALESCER. A tube (unit/element) that unites water droplets in the fuel.

COFFERDAM. The space surrounding the AvGas stowage tanks aboard ship; a watertight box.

COME-ALONG. Ratchet hoist.

COMMINGLING. Intermixing.

CONTIGUOUS. In physical contact.

CONTINGENCY. Something incidental to another thing.

COSAL. A management document that provides the supply officer with a listing of what material to stock in the storerooms.

DIAPHRAGM. Any separating membrane or device.

DIFFUSE. To spread widely, scatter.

DIFFUSER. A device used to spread protective gas in a cofferdam.

DOUBLE-WALLED PIPING. Inside pipe carries gasoline, outside pipe carries protective gas.

EDUCTOR. Pump for a vacuum.

ELECTROLYTE. A solution capable of conducting an electric current.

ELLIPTICAL. Of, or having the form of, an ellipse.

ERRATA SHEET. Will inform you of changes to text of RTM or NRCC.

ERRATIC. Having no fixed course.

ESTHETIC. Sensitive to art and beauty.

EUTROPHICATION. The dying of lakes.

EXFOLIATION. Scales or layers of metal; bark.

FLASH POINT. The lowest temperature at which the fuel will vaporize enough to form a combustible vapor.

FRETTING. To eat away, gnaw. A form of corrosion.

FUSIBLE PLUGS. Melting plugs that allow fuel vapors to escape.

GALVANIC. Producing an electric current. Corrosion produced by an electric current.

HOT REFUELING. Aircraft refueling with engines operating.

HAWSER. A line of any size over 5 inches.

HERS. Helicopter Expedient Refueling System.

HYDROCARBONS. Any compound containing only hydrogen and carbon.

HYDROSTATIC. The branch of physics having to do with the pressure and equilibrium of water and other liquids.

ICC. Interstate Commerce Commission.

INERT. With few or no active properties.

INTERGRANULAR. Corrosion from or the condition from being heated and cooled too fast or too slow.

INTERIM. Between two periods of time.

INERTIA. The ability of matter to remain at rest; or if moving, moving in the same direction.

KNOCKVALUE. Designations of relative measurements of the tendency of gasoline to knock when used in spark ignition reciprocating engines.

LAGGING. Heat or cold insulating material.

MEMBRANE. A thin, soft, pliable layer of tissue that covers a part.

MICROBIOLOGICAL. Any of the bacteria that causes disease; gum.

MICROORGANISMS. A very minute living thing, whether plant or animal.

MODULAR. A standard or unit of measurement, especially of flowing water.

N_2. Nitrogen.

NAPCA. National Air Pollution Control Administration.

NAVEDTRA. Naval Education Training.

ND. Navy distallant fuel.

NITROGEN FIXATION. The chemical and electrical process by which nitrogen is taken from the air.

NITROGEN GAS. Used for preventing and extinguishing fires in the aviation fuels system aboard ship.

NONFERROUS. Not containing iron.

NONSPARKING TOOLS. Tools made of brass, aluminum, etc.

NSFO. Navy special fuel oil.

PARTICULATE MATTER. Particles of solid or liquid substances found in the air.

PCV. Positive crankcase ventilation.

PHOTOCHEMICAL OXIDANTS. A complex variety of pollutants formed when nitrogen oxides combine with gaseous hydrocarbons and are subjected to sunlight.

PITCH GAGE. Used to measure the distance between two corresponding points.

PITTING. Cavities on the surface of metal.

PNEUMATICALLY. Operated by air pressure.

PORTABLE INERTNESS ANALYZER. An instrument used to determine the percent of protective gas present in a space in order to prevent fires.

POTENTIOMETER. Power gage.

POWER TAKEOFF LOCK-OUT. Air interlock system to prevent simultaneous propelling of the vehicle and operation of the pumping equipment.

PTO. Power takeoff switch.

PURGE. To cleanse of impurities.

PURGING. To become clean, clear, or pure.

QUADRANT. A unit of the fuels system aboard a carrier where the fuel is available to aircraft.

RHEOSTAT. A variable resistor; used to regulate the amount of electrical current.

SAFEGUARDS. Protection/precaution(s).

SATURATED STEAM. Steam which contains moisture.

SHEAVES. Pulleys over which rope runs.

SLUICE. Any channel, especially one for excess water.

SOLVENCY. Ability to dissolve a number of materials.

SPECIFIC GRAVITY. The ratio of the weight or mass of a given volume of a substance to that of an equal volume of another substance (water for liquid and air or hydrogen for gases) used as a standard.

STATIC CHARGE REDUCER. The dissipation of static electricity.

STATIC ELECTRICITY. Stationary electrical charge.

SULFUR DIOXIDE. A heavy, colorless, suffocating gas.

SUPERHEATED STEAM. Steam which is hotter than the boiling point of water.

TAFDS. Tactical Airfield Fuel Dispensing System.

TETRAETHYLLEAD. A poisonous lead compound added to gasoline.

TURBINE. An engine driven by the pressure of steam, water, or air against the curved vanes of a wheel.

VALIDATION. The physical inventory of equipment.

VAPORIZE. To change into vapor by heating or spraying.

VENTURI. A device to measure the velocity of flow of a liquid or gas.

VISCOSITY. The internal fluid resistance of a substance, caused by molecular attraction.

VOLATILITY. The term used to measure vapor pressure and distillation of a petroleum fuel.

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QUALIFICATIONS FOR ADVANCEMENT

AVIATION BOATSWAIN'S MATE F (Fuels) - ABF 3 & 2

Aviation Boatswain's Mates (F) operate, maintain, and perform organizational maintenance on aviation fueling and lubricating oil systems in CVA, CVS, LPH and LPDs including aviation fuel and lubricating oil service stations and pumprooms, piping, valves, pumps, tanks, and portable equipment related to the fuel system; operate, maintain, and repair valves and piping of purging and protective systems within the Air Department spaces aboard ship; supervise the operation and servicing of fuel farms, and equipment associated with the fueling and defueling of aircraft ashore and afloat; operate and service motorized fueling equipment; maintain fuel quality surveillance and control in aviation fuel systems ashore and afloat; train, direct, and supervise firefighting crews, fire rescue teams, and damage control parties in assigned fuel and lubricating oil spaces; and observe and enforce fuel-handling safety precautions.

QUALIFICATIONS FOR ADVANCEMENT	Required for Advancement to ABF	Covered in Assignment
A. SAFETY		
1.00 Practical Factors		
.01 Observe safety precautions applicable to steam, liquids, and gases under pressure and energized electrical circuits	E-4	2
.04 Observe safety precautions:		
a. When entering and working in aviation fuel pumprooms, fuel tanks, cofferdams, voids, and spaces filled with gasoline or fuel vapors. . . .	E-4	3, 4, 7
b. In handling, stowing, and disposing of contaminated aviation fuel filter elements and sludge.	E-4	3
c. In handling aviation fuel and lubricating oil and in fueling and defueling aircraft ashore and afloat.	E-4	4, 5, 6, 7, 8
.05 Observe safety precautions and restrictions applicable to common hand and mandatory non-sparking tools used in the repair and maintenance of aviation fuel systems.	E-4	1, 7
.07 Inspect own work areas, tools, and equipment to detect potentially hazardous and unsafe conditions, and initiate corrective action.	E-4	7

QUALIFICATIONS FOR ADVANCEMENT		Required for Advancement to ABF	Covered i Assignment
D.	AVIATION FUEL SYSTEMS AND EQUIPMENT		
1.00	Practical Factors		
.02	Select and use lubricants in the maintenance of aviation fuel systems	E-4	4, 5, 6, 7
.03	Purge aviation fuel system piping, cofferdams, and voids	E-4	4, 6
.04	Operate mobile fueling and lube oil equipment ashore.	E-4	7, 8
.05	Operate fixed and portable eductors	E-4	3, 4
.06	Use portable inertness analyzers.	E-4	7
.07	Fuel and defuel aircraft.	E-4	4, 5, 6, 7 8
.08	Maintain and make entries in daily pumproom logs.	E-4	4, 6, 7
.09	Take samples of aviation fuel and determine water and solid contents using latest equipment	E-4	2, 3
.11	Drain and clean filter separators	E-4	2, 3
.12	Operate fuel pump and filter rooms.	E-4	3
.13	Aline valves in the fuel system for the receipt and transfer of aviation fuels.	E-4	4, 5, 6
.14	Use flame safety lamps and combustible gas indicators.	E-4	7
.43	Replace components of aviation fuel and lube oil systems	E-5	3, 6, 7
.44	Supervise crews in the fueling and defueling of aircraft.	E-5	7, 8
.45	Conduct tests on filter elements.	E-5	3
2.00	Knowledge Factors		
.01	Pressure limitations of tanks, voids, and piping of aviation fuel systems and nitrogen distribution systems	E-4	4, 5, 6
.03	Principles and nomenclature of aviation fuel, lube oil and CO_2 systems and the nitrogen distribution system	E-4	4, 5, 6
.04	Procedures for alining valves to isolate and bypass inoperative sections of aviation fuel systems	E-4	4, 5, 6
.05	Procedures for:		
	a. Pumping fuel to service stations.	E-4	4, 5, 6
	b. Draining back and inerting aviation fuel systems	E-4	3, 4, 6
	c. Receipt and transfer of aviation fuels.	E-4	3, 4, 5, 6
.41	Procedures for using CO_2 as a replacement for nitrogen in purging and inerting aviation fuel systems	E-5	6
.42	Procedure for emergency breakaway during fueling at sea operations	E-5	3, 4

UALIFICATIONS FOR ADVANCEMENT		Requ[illegible] for Advancement to ABF	Covered in Assignment
	CRASH RESCUE AND DAMAGE CONTROL		
1.00	Practical Factors		
.01	Operate:		
	a. Damage control fittings and equipment in Air Department spaces aboard carriers and life saving apparatus	E-4	7
	b. Crash firefighting equipment	E-4	7
.59	Direct:		
	a. Unit of an aviation fuel damage control repair party	E-5	7
2.00	Knowledge Factors		
.01	Properties and hazards of aviation fuels	E-4	2, 3, 4
.02	Characteristics of aviation fuel fires and procedures and equipment used in fighting them	E-4	7
.03	Duties and responsibilities of:		
	a. Aviation fuel damage control repair party	E-4	7
	GENERAL MAINTENANCE PRACTICES AND PROCEDURES		
1.00	Practical Factors		
.01	Select, use, and maintain common hand tools, portable power tools, and measuring instruments	E-4	1, 2
.40	Supervise stowage, preservation, accounting for, and replacement of spare parts and equipment	E-5	2
.42	Read and work from blueprints and drawings	E-5	1
.43	Use technical publications and parts catalogs to identify equipment components, assemblies, and subassemblies	E-5	2
2.00	Knowledge Factors		
.01	Types and uses of wire rope, manila line, and nylon webbing and thumb rules for computing safe working loads	E-4	1
.02	Color coding for identification of steam, air, fuel, and firefighting equipment	E-4	1, 7
.03	Fundamentals of electricity, hydraulics, and basic machines	E-4	1
.04	Paints, solvents, lubricants, and preservatives used in maintenance and preservation of equipment	E-4	1
.05	Characteristics of compressed gases and steam	E-4	1
.06	Fundamentals of corrosion detection and control	E-4	1

QUALIFICATIONS FOR ADVANCEMENT	Required for Advancement to ABF	Covered in Assignment
Z. ADMINISTRATION		
1.00 Practical Factors		
.30 Identify categories of material contained in each volume of Coordinated Shipboard/Shorebase Allowance List (COSAL).	E-4	2
.50 Inventory installed equipment and verify spare part support in COSAL	E-5	2
.51 Order repair parts and special tools required for installed equipment maintenance using COSAL	E-5	2
.59 In accordance with the Planned Maintenance Sub-System of the Navy Maintenance and Material Management System:		
a. Assist in the preparation of a weekly schedule of preventive maintenance	E-5	BMR NAVPERS 10054-C
BB. ENVIRONMENTAL POLLUTION CONTROL		
1.00 Practical Factors		
None.		
2.00 Knowledge Factors		
.01 Effect of incomplete combustion of fuels on air pollution	E-4	8
.02 Fuel components and combustion products which adversely affect air.	E-4	8
.03 Means of controlling air pollution caused by fuel combustion	E-4	8
.04 Possible pollution threats due to oil and other fuel product spillage on the water or ground.	E-4	8
.05 Procedures for limiting or minimizing the adverse effects of oil and fuel spillage.	E-4	8

AVIATION BOATSWAIN'S MATE F 3 & 2

NAVEDTRA 10301-D

Prepared by the Naval Education and Training Program Development
Center, Pensacola, Florida

Your NRCC contains a set of assignments and self-scoring answer sheets (packaged separately). The Rate Training Manual, Aviation Boatswain's Mate F 3 & 2, NAVEDTRA 10301-D, is your textbook for the NRCC. If an errata sheet comes with the NRCC, make all indicated changes or corrections. Do not change or correct the textbook or assignments in any other way.

COURSE OBJECTIVE

The broad objective of this course is that as you progress through the course you will demonstrate an understanding of the subject matter by correctly answering items based on: the enlisted rating structure, qualifications for advancement, types of training material, and sources of information; general maintenance including blueprints and drawings, handtools, rigging equipment, technical publications, hydraulics, electricity, basic machines, and corrosion control; aviation fuels and related safety precautions; aviation fuels contamination, detection and prevention; high-capacity gasoline systems; high-capacity JP-5 systems; protection systems; the aviation lube oil system; aviation fuels repair team; fuel farms and mobile refuelers; fueling, defueling, and purging aircraft fuel systems; and environmental pollution control.

HOW TO COMPLETE THIS COURSE SUCCESSFULLY

Study the textbook pages given at the beginning of each assignment before trying to answer the items. Pay attention to tables and illustrations as they contain a lot of information. Making your own drawings can help you understand the subject matter. Also, read the learning objectives that precede the sets of items. The learning objectives and items are based on subject matter or study material in the textbook. The objectives tell you what you should be able to do by studying assigned textual material and answering the items.

At this point you should be ready to answer the items in the assignment. Read each item carefully. Select the BEST ANSWER for each item, consulting your textbook when necessary. Be sure to select the BEST ANSWER from the subject matter in the textbook. You may discuss difficult points in the course with others. However, the answer you select must be your own. Use only the self-scoring answer sheet designated for your assignment. Follow the scoring directions given on the answer sheet itself and elsewhere in this course.

Your NRCC will be administered by your command or, in the case of small commands, by the Naval Education and Training Program Development Center. No matter who administers your course you can complete it successfully by earning grades that average 3.2 or higher. If you are on active duty, the average of your grades in all assignments must be at least 3.2. If you are NOT on active duty, the average of your grades in all assignments of each creditable unit must be at least 3.2. The unit breakdown of this course, if any, is shown later under Naval Reserve Retirement Credit.

WHEN YOUR COURSE IS ADMINISTERED BY LOCAL COMMAND

As soon as you have finished an assignment, submit the completed self-scoring answer sheet to the officer designated to administer it. He will check the accuracy of your score and discuss with you the items that you do not understand. You may wish to record your score on the assignment itself since the self-scoring answer sheet is not returned.

If you are completing this NRCC to become eligible to take the fleetwide advancement examination, follow a schedule that will enable you to complete all assignments in time. Your schedule should call for the completion of at least one assignment per month.

Although you complete the course successfully, the Naval Education and Training Program Development Center will not issue you a letter of satisfactory completion. Your command will make a note in your service record, giving you credit for your work.

WHEN YOUR COURSE IS ADMINISTERED BY THE NAVAL EDUCATION AND TRAINING PROGRAM DEVELOPMENT CENTER

After finishing an assignment, go to the next. Retain each completed self-scoring answer sheet until you finish all the assignments in a unit (or in the course if it is not divided into units). Using the envelope provided, mail your self-scored answer sheets to the Naval Education and Training Program Development Center where scores will be verified and recorded. Make sure all blanks at the top of each answer sheet are filled in. Unless you furnish all the information required, it will be impossible to give you credit for your work. You may wish to record your scores on the assignments since the self-scoring answer sheets are not returned.

The Naval Education and Training Program Development Center will issue a letter of satisfactory completion to certify successful completion of the course (or a creditable unit of the course). To receive a course-completion letter follow the directions given on the course-completion form in the back of this NRCC.

You may keep the textbook and assignments for this course. Return them only in the event you disenroll from the course or otherwise fail to complete the course. Directions for returning the textbook and assignments are given on the course-disenrollment form in the back of this NRCC.

NAVAL RESERVE RETIREMENT CREDIT

This course is evaluated at 12 Naval Reserve retirement points. These points are creditable to personnel eligible to receive them under current directives governing retirement of Naval Reserve personnel. Points will be credited upon satisfactory completion of entire course. Naval Reserve retirement credit will not be given for this course if the student has previously received retirement credit for any Aviation Boatswain's Mate F 3&2 ECC, ECC/FITS, or NRCC.

PREPARING FOR YOUR ADVANCEMENT EXAMINATION

Your examination for advancement is based on the Manual of Qualifications for Advancement (NAVPERS 18068). The sources of questions in this examination are given in the Bibliography for Advancement Study (NAVEDTRA 10052). Since your NRCC and textbook are among the sources listed in this bibliography, be sure to study both in preparing to take your advancement examination. The qualifications for your rating may have changed since your course and textbook were printed, so refer to the latest edition of NAVPERS 18068 and NAVEDTRA 10052.

Naval nonresident career courses may include a variety of items -- multiple-choice, true-false, matching, etc. The items are not grouped by type; regardless of type, they are presented in the same general sequence as the textbook material upon which they are based. This presentation is designed to preserve continuity of thought, permitting step-by-step development of ideas. Some courses use many types of items, others only a few. The student can readily identify the type of each item (and the action required of him) through inspection of the samples given below.

MULTIPLE-CHOICE ITEMS

Each item contains several alternatives, one of which provides the best answer to the item. Select the best alternative and erase the appropriate box on the answer sheet.

SAMPLE

s-1. The first person to be appointed Secretary of Defense under the National Security Act of 1947 was

1. George Marshall
2. James Forrestal
3. Chester Nimitz
4. William Halsey

The erasure of a correct answer is indicated in this way on the answer sheet:

	1 T	2 F	3	4	
s-1	■	C	■	■	

TRUE-FALSE ITEMS

Determine if the statement is true or false. If any part of the statement is false the statement is to be considered false. Erase the appropriate box on the answer sheet as indicated below.

SAMPLE

s-2. Any naval officer is authorized to correspond officially with a bureau of the Navy Department without his commanding officer's endorsement.

The erasure of a correct answer is also indicated in this way on the answer sheet:

	1 T	2 F	3	4	
s-2	■	CC	■	■	

MATCHING ITEMS

Each set of items consists of two columns, each listing words, phrases or sentences. The task is to select the item in column B which is the best match for the item in column A that is being considered. Specific instructions are given with each set of items. Select the numbers identifying the answers and erase the appropriate boxes on the answer sheet.

SAMPLE

In items s-3 through s-6, match the name of the shipboard officer in column A by selecting from column B the name of the department in which the officer functions.

A. Officers	B. Departments
s-3. Damage Control Assistant	1. Operations Department
s-4. CIC Officer	2. Engineering Department
s-5. Assistant for Disbursing	3. Supply Department
s-6. Communications Officer	

The erasure of a correct answer is indicated in this way on the answer sheet:

	1 T	2 F	3	4	
s-3	■	C	■	■	
s-4	C	■	■	■	
s-5	■	■	C	■	
s-6	C	■	■	■	

How To Score Your Immediate Knowledge of Results (IKOR) Answer Sheets

	1 T	2 F	3	4	
1	■	C	6	■	1
2	C	9	■	9	2
3	■	■	C	■	
4	CC	12	■	■	1

Total the number of incorrect erasures (those that show page numbers) for each item and place in the blank space at the end of each item.

Sample only

Number of boxes erased incorrectly	0-2	3-7	8-
Your score	4.0	3.9	3.8

Now TOTAL the column(s) of incorrect erasures and find your score in the Table at the bottom of EACH answer sheet.

NOTICE: If, on erasing, a page number appears, review text (starting on that page) and erase again until "C", "CC", or "CCC" appears. For courses administered by the Center, the maximum number of points (or incorrect erasures) will be deducted from each item which does NOT have a "C", "CC", or "CCC" uncovered (i.e., 3 pts. for four choice items, 2 pts. for three choice items, and 1 pt. for T/F items).

While working on a course a student may refer freely to open-book texts and references. He may seek advice and instruction from others on problems arising in the course, but the solutions submitted must be the result of the student's own work and decisions. The student is prohibited from referring to or copying the solutions of others, or giving completed solutions to anyone else taking the same course. Noncompliance can result in suspension from the course by the administering activity and disciplinary action by the Chief of Naval Personnel.

Assignment 1

Aviation Boatswain's Mate Rating; General Maintenance

Text: Pages 1 - 34

In this course you will demonstrate that learning has taken place by correctly answering training items. The mere physical act of indicating a choice on an answer sheet is not in itself important; it is the mental achievement, in whatever form it may take, prior to the physical act that is important and toward which nonresident career course learning objectives are directed. The selection of the correct choice for a course training item indicates that you have fulfilled, at least in part, the stated objective(s).

The accomplishment of certain objectives, for example, a physical act such as drafting a memo, cannot readily be determined by means of objective type course items; however, you can demonstrate by means of answers to training items that you have acquired the requisite knowledge to perform the physical act. The accomplishment of certain other learning objectives, for example, the mental acts of comparing, recognizing, evaluating, choosing, selecting, etc., may be readily demonstrated in a course by indicating the correct answers to training items.

The comprehensive objective for this course has already been given. It states the purpose of the course in terms of what you will be able to do as you complete the course.

The detailed objectives in each assignment state what you should accomplish as you progress through the course. They may appear singly or in clusters of closely related objectives, as appropriate; they are followed by items which will enable you to indicate your accomplishment.

All objectives in this course are learning objectives and items are teaching items. They point out important things, they assist in learning, and they should enable you to do a better job for the Navy.

This self-study course is only one part of the total Navy training program; by its very nature it can take you only part of the way to a training goal. Practical experience, schools, selected reading, and the desire to accomplish are also necessary to round out a fully meaningful training program.

Learning Objective: Recognize the types of ratings and responsibilities applicable to ABF personnel.

1-1. A general rating is one which reflects qualifications in
  1. civilian skills identified with a peacetime Navy
  2. civilian skills identified with a wartime Navy
  3. broad occupational fields of related duties and functions
  4. subdivisions or specialties within broad occupational fields

1-2. The rating structure for naval personnel in the Aviation Boatswain's Mate rating at pay grades E-4 through E-7 provides for
  1. a general rating only
  2. three service ratings only
  3. one general rating and two service ratings
  4. three general ratings within one service rating

1-3. Refer to figure 1-2A in your textbook. In order to advance from ABF3 to ABF2, what must you do?
1. Have been an ABF3 for at least 1 year
2. Demonstrate your ability to perform the applicable practical requirements
3. Pass the applicable written examinations on military/leadership and professional requirements
4. All of the above

1-4. Flight deck fueling crews are normally under the direction of an
1. ABF3
2. ABF2
3. ABF1
4. ABFC

Learning Objective: Indicate principles of good leadership and the relationship of leadership to advancement.

1-5. The most important aspects of leadership are published in
1. Secretary of the Navy Instructions
2. General Order No. 21
3. OPNAV Notice 1414
4. BUPERS Instructions

1-6. The term leadership is based on managing people successfully through which principle(s)?
1. Personal example
2. Moral responsibility
3. Good management practices
4. All of the above

1-7. Which of the following publications should an ABF striker study in order to learn the leadership qualities expected of him when he advances to a petty officer rate?
1. Aviation Boatswain's Mate F 3 & 2, NAVEDTRA 10301 (Series)
2. Bibliography for Advancement Study, NAVEDTRA 10052 (Series)
3. Military Requirements for Petty Officer 3 & 2, NAVEDTRA 10056 (Series)
4. List of Training Manuals and Correspondence Courses, NAVEDTRA 10061 (Series)

1-8. As an ABF advances, his success is judged increasingly in terms of the
1. amount of work he does
2. amount of efficient work his men do
3. number of different billets he has filled
4. neatness and orderliness of the work areas for which he is responsible

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Learning Objective: Recognize advantages of, procedures for, and materials to be studied in preparing for advancement.

1-9. The publication that outlines the minimum professional requirements for advancement in the ABF rating is the
1. Bibliography for Advancement Study (formerly Training Publications for Advancement), NAVEDTRA 10052 (Series)
2. List of Training Manuals and Correspondence Courses, NAVEDTRA 10061 (Series)
3. Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards, NAVPERS 18068 (Series)
4. Aviation Boatswain's Mate F 3 & 2, NAVEDTRA 10301 (Series)

1-10. The professional qualifications and military requirements for the ABF3 and ABF2 rates are given in the Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards, NAVPERS 18068 (Series), as
1. knowledge factors
2. examination subjects and military factors
3. occupational standards
4. practical factors and military factors

1-11. Occupational standards are divided into two general types of requirements. One is military and the other is
1. knowledge
2. practical
3. technical
4. task

1-12. The Record of Practical Factors, NAVEDTRA 1414/1 (AB), forms a part of each ABF's service record and provides a history of his ________
1. general performance on the job
2. grades of examinations required for advancement
3. demonstration of skills required for advancement
4. military qualifications in relation to other men in his rating

1-13. What is the main difference between occupational standards and Personnel Qualification Standards (PQS)?
1. PQSs are specific, and occupational standards are more general
2. Occupational standards are specific, and PQSs are more general
3. PQSs are pointed toward knowledge, and occupational standards are toward tasks
4. Occupational standards are pointed toward knowledge, and PQSs are toward tasks

1-14. Before being eligible to take the Navy-wide advancement exam for a rate, the ABF must complete those training manuals marked with an asterisk (*) in the
1. "Quals" Manual
2. Manual of Navy Enlisted Classifications, NAVEDTRA 15106 (Series)
3. Bibliography for Advancement Study, NAVEDTRA 10052 (Series)
4. List of Training Manuals and Correspondence Courses, NAVEDTRA 10061 (Series)

Learning Objective: Identify types of Rate Training Manuals, how they are numbered, and the publication which lists the most current editions.

1-15. The general qualifications which all enlisted personnel are expected to demonstrate as a minimum for advancement at all rate levels are
1. knowledge factors
2. practical factors
3. military requirements
4. professional qualifications

1-16. The word "basic" as used in Rate Training Manual titles has which of the following meanings relative to the material in the manual?
1. The material is common to several Navy ratings
2. The material should be studied by all Navy personnel
3. The material is simple and fundamental enough to be understood by beginners
4. The material is basic or fundamental to the rating from which the title of the manual is derived

1-17. You can find out if your copy of a particular Rate Training Manual is the latest revision by referring to the current edition of the
1. Bibliography for Advancement Study, NAVEDTRA 10052 (Series)
2. Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards, NAVPERS 18068 (Series)
3. List of Training Manuals and Correspondence Courses, NAVEDTRA 10061 (Series)
4. Record of Practical Factors, NAVEDTRA 1414/1

Learning Objective: Recognize the purpose of Rate Training Manuals, the reason for taking Nonresident Career Courses, the recommended way to study a training manual, and how the latest professional information can be obtained.

1-18. It is recommended that in studying a Rate Training Manual for advancement, one should begin by
1. outlining the entire manual
2. becoming familiar with the entire manual
3. preparing a list of questions to be answered as study progresses
4. reading the introductions, headings, and subheadings of each chapter

1-19. The reason why suggestions 4 and 7 are included in the list of suggestions given in your textbook is that in following them you
1. write an outline of the entire course which will be a valuable reference for future study
2. are able to peg each subject to an individual qualification as given in the "Quals" manual
3. are able to separate the military qualifications from the professional qualifications in the textbook
4. familiarize yourself with the aims and contents of the course and relate the subject areas to your past experience, thereby creating an excellent learning situation

1-20. Which of the following statements relative to Nonresident Career Courses (NRCCs) is INCORRECT?

1. The purpose of the learning objectives is to indicate knowledges you should acquire by choosing the correct answer to each question
2. The IKOR answer sheets used with the course provide immediate results of your answer to each item
3. An errata sheet, which is provided with each NRCC, contains complete instructions for taking the course
4. In addition to assisting you in the training necessary to fulfill your job and advancement requirements, the NRCC should be of benefit to you in preparing for advancement examinations

1-21. On what is the final multiple score based?

1. Performance only
2. Advancement test only
3. Seniority and performance only
4. Performance, advancement test, and seniority

1-22. What indicates the sections of the advancement examinations which represent the occupational requirements for the rate?

1. The Rate Training Manual for the rate
2. The Nonresident Career Course for the rate
3. The Bibliography for Advancement Study
4. The Subject-Matter Section Identification Sheet

1-23. What indicates your strengths and weaknesses from the results of the advancement examination?

1. The Profile Analysis Form
2. The Subject-Matter Section Identification Sheet
3. The Record of Practical Factors
4. The Manual of Navy Enlisted Manpower and Personnel Classification and Occupational Standards

1-24. Which single publication, if any, can give you all the information you need to perform the duties of your rating?

1. The "Quals" Manual
2. The Rate Training Manual for your rate
3. The Bibliography for Advancement Study
4. None

1-25. What office can supply you with a Rate Training Manual?

1. The administrative office
2. The educational services office
3. The division office
4. The supply office

1-26. Who organizes and supervises your training for advancement in rating?

1. Leading petty officer
2. Education services officer
3. Training petty officer
4. Division officer

Learning Objective: Recognize the ABF's responsibilities concerning the care and maintenance of equipment he uses and identify reasons why certain types of handtools and power tools may or may not be used for the maintenance and repair of aviation fuel systems.

1-27. An ABF's responsibilities include operation of the equipment he uses. What additional knowledge of the equipment must he possess?

1. How to preserve the equipment only
2. How to replace worn or broken parts only
3. How to obtain materials needed to keep the equipment operative only
4. How to preserve the equipment, replace worn and broken parts, and obtain material needed to keep the equipment operative

1-28. Why are handtools of brass, lead, or aluminum more commonly used by ABFs than steel tools?

1. Because tools made of brass, lead, and aluminum are more easily used than steel tools
2. Because steel tools may cause sparks which could ignite fuel vapors
3. Because brass, lead, and aluminum tools will not cause sparks when struck against a metal surface
4. Both 2 and 3 above

1-29. What is the primary reason why electrically-driven power tools can NOT be used by ABFs except under particular conditions?
1. The steel accessories that are used with the tools may cause sparks which could ignite fuel vapors
2. Electrical sparks may ignite fuel vapors
3. The aluminum coverings, casings, and housings for electrically-driven tools can cause sparks which may ignite fuel vapors
4. The cords to electrically-driven tools can create static electricity as they are pulled across decks and around machinery and can cause sparks which may ignite fuel vapors

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Learning Objective: Identify construction features, working capacities, descriptive terms, and handling procedures applicable to blocks and tackles, chain hoists, and wire rope and line.

1-30. What is the mechanical advantage of a simple tackle when an object is lifted with a threefold purchase?
1. Six
2. Five
3. Three
4. Four

1-31. What amount of force is required to lift a 720-pound load with a two-fold purchase tackle?
1. 144 lb
2. 180 lb
3. 240 lb
4. 360 lb

It items 1-32 through 1-34, select from column B the type of chain hoist that is equipped with each of the features listed in column A.

	A. Features	B. Types
1-32.	A single endless chain which provides both lifting and operating functions	1. Worm gear
1-33.	An operating chain and a load chain with both ends of the load chain attached to a swivel lifting hook	2. Differential
1-34.	A mechanical friction brake to hold a suspended load	3. Spur gear

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1-35. What is the difference between a 6 x 37 rope and a 6 x 19 wire rope of the same size?
1. The 6 x 37 is left-laid
2. The 6 x 37 has longer wires in each strand
3. The 6 x 37 has more wires in each strand
4. The 6 x 37 has more strands

1-36. Which grouping lists the components of a line in increasing size progression?
1. Fibers → strands → yarns
2. Fibers → yarns → strands
3. Strands → fibers → yarns
4. Yarns → fibers → strands

1-37. A line 6 inches in circumference is generally called a
1. cable
2. halyard
3. hawser
4. houseline

1-38. In determing the size of small stuff, you open the line and find it has 3 strands. If each of these strands has 6 yarns, the line is designated as
1. 12 thread
2. 16 thread
3. 18 thread
4. 23 thread

1-39. At what minimum percent of stretch will nylon part?
1. 70 percent
2. 60 percent
3. 50 percent
4. 40 percent

1-40. Nylon line will hold a good portion of its rated load even though a considerable number of the yarns have been abraded.

1-41. Because of its smoothness and elastic properties, nylon line requires how many more tucks than manila line when it is spliced?
1. One
2. Two
3. Three
4. Four

1-42. Which rope should NOT be used on a block that is designed for manila line?
1. Wire
2. Nylon
3. Hemp
4. Fiber

1-43. How should the three U bolts, used on cable slips, be placed when used on wire rope?
1. All three over the bitter end
2. All three over the standing part
3. Two over the bitter end and one over the standing part
4. Two over the standing part and one over the bitter end

1-44. What type of knot is reasonably secure to use on synthetic lines?
1. Becketbend
2. Square knot
3. Bowline
4. Halfhitch

1-45. How many different colors are used in manufacturing webbing?
1. Five
2. Six
3. Three
4. Four

Learning Objective: Recognize causes, effects, and characteristics of different types of metal corrosion and identify proper preservation methods, including uses and application procedures applicable to paints.

1-46. Which of the following statements relative to the causes and effects of metal corrosion is INCORRECT?
1. Corrosion is the deterioration of the surface and internal areas of metal and is caused by a chemical or electrochemical attack
2. The effects of corrosion of metal structures are similar to the effects of rotting of wood structures
3. Since the mixture of salt water vapor with oxygen in the atmosphere is the main source of corrosion, equipment aboard aircraft carriers is especially susceptible to corrosive attack
4. Since the fumes from most industrial plants contain particles which provide a protective film when deposited on metal surfaces, equipment utilized in such areas is not highly susceptible to corrosion

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In items 1-47 through 1-49, select from column B the surface condition which indicates corrosion of each metal listed in column A.

	A. Metals	B. Surface Conditions
1-47.	Aluminum	1. Greenish film
1-48.	Copper	2. Gray or white powdery deposit
1-49.	Steel	
		3. Reddish rust deposit

1-50. How is the presence of surface corrosion of metal indicated?
1. By blisters of paint or plating over the surface only
2. By pits in the surface only
3. By powdery deposits on the surface only
4. By blisters of paint or plating over the surface, pits in the surface, and powdery deposits on the surface

1-51. Which form of corrosion occurs when the failure of an insulator allows two different types of metals to come in to direct contact with one another?
1. Stress corrosion
2. Intergranular corrosion
3. Fretting corrosion
4. Dissimilar metal corrosion

In items 1-52 through 1-54, select from column B a cause for each type of corrosion listed in column A.

	A. Types		B. Causes
1-52.	Intergranular	1.	The combined effects of sustained tensile stresses and a corrosive environment
1-53.	Stress		
1-54.	Fretting	2.	The lack of uniformity in the alloy structure, which, in turn, is caused by changes that occur in the alloy during heating and cooling
		3.	The slight motion of two mating parts which are normally at rest with respect to each other

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1-55. When corrosion causes layers of aluminum alloys to peel off it is called
1. pitting
2. crevice attack
3. exfoliation
4. galvanic

1-56. The presence of stress corrosion in metal is indicated by
1. cracks
2. pits
3. blisters
4. bends

1-57. Which of the following sustances should be used on moving parts to prevent corrosion?
1. Paints
2. Solvents
3. Lubricants
4. Preservative compounds

1-58. Which of the following terms best indicates the primary purpose of paint?
1. Brighten
2. Beautify
3. Preserve
4. Sanitize

1-59. Why is light-colored paint used on the interior of a ship?
1. For camouflage purposes
2. To distribute light
3. For identification purposes
4. Because it is easier to apply

1-60. An ABFAN is assigned the task of painting a piece of fueling machinery in the JP-5 pumproom. What should he NOT paint?
1. The machined external parts of the valves
2. The joint faces of the gaskets and packing surfaces
3. The machined metal parts of the pump
4. All of the above

1-61. You must NOT do which of the following if you are to obtain a first class paint job?
1. Apply the finish correctly
2. Clean the surface properly
3. Use the recommended finish
4. Apply to a wet surface

1-62. JP-5 piping painted gray, labeled as to its contents, and having arrows painted on it to denote direction of flow will most likely be what type of piping?
1. Interior shipboard piping
2. Exterior shipboard piping
3. Interior piping at a fuel farm
4. Exterior piping at a fuel farm

Learning Objective: Recognize the purpose of different types of prints and the difference between sketches and drawings, and identify symbols used to illustrate fuel system components on schematics.

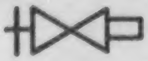
1-63. Which of the following terms indicates the basic difference between a sketch and a drawing?
1. Print
2. Instrument
3. Blueprint
4. Scale

1-64. The type of blueprint which shows the location and use of your duty station is referred to as a/an
1. plan view
2. detail print
3. installation diagram
4. assembly print

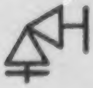
1-65. If you need to study the operation of a JP-5 service pump, your best sources for establishing the relationship of the pump to other components in the JP-5 system will be
1. plan views of the entire system
2. assembly and subassembly prints
3. unit and division prints
4. unit and plan prints

● Refer to the following schematic symbols taken from figure 2-14 in your textbook in answering items 1-66 through 1-68.

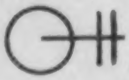
A.



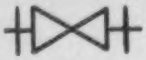
B.



C.



D.



1-66. Which symbol indicates a gate hose valve?
1. A
2. B
3. C
4. D

1-67. What do B and D hold in common?
1. They are both valves
2. They are both pumps
3. They are both filter/separators
4. They are both piping connections

1-68. An elbow-turn-down is represented by which symbol?
1. A
2. B
3. C
4. D

Learning Objective: Indicate how the effects of static electricity are controlled during aircraft fueling and recognize the concepts of Pascal's law and Bernoulli's principal.

1-69. The concept of static electricity is important to the ABF because of the electrons imparted to the hose by the fuel flowing through it and the surplus electrons on the aircraft imparted by the flow of air. As a result of this, when aircraft are fueled, what should the ABF ground?
1. The hose but not the aircraft
2. The aircraft but not the hose
3. Both the aircraft and the hose
4. The hose to the pump and the aircraft to the deck

1-70. Indicate in the spaces provided if each statement concerning Pascal's law is true or false, then select the alternative which lists the statments that are true.

___A. Pressure in a liquid acts equally and undiminished in every direction throughout the container

___B. The shape of a container in which a liquid is contained in no way alters pressure relations

___C. The vertical distance between two horizontal levels in a liquid is known as the head of the liquid at the lower level with respect to the higher

1. A and B only
2. A and C only
3. A, B, and C
4. B and C only

1-71. Which of the following is an accurate statement of the application of Bernoulli's principle?
1. Fluid decreases in pressure and increases in speed when it flows through a constriction
2. Fluid increases in pressure and decreases in speed when it flows through a constriction
3. Fluid increases in pressure and speed when it flows through a constriction
4. Fluid decreases in pressure and speed when it flows through a constriction

1-72. The constriction referred to in the preceding item is know as a/an
1. eductor
2. venturi
3. water hammer
4. chamber

Assignment 2

General Maintenance; Characteristics and Properties of Aviation Fuels; Aviation Fuels Contamination

Text: Pages 35 - 61

Learning Objective: Indicate characteristics and uses of various types of compressed gasses, hazards involved in handling these products, and safety precautions to be observed.

2-1. Which of the following is NOT a use of CO_2?
1. Refrigeration
2. Inflation
3. Propellant
4. Breathing agent

2-2. When a heavy concentration of CO_2 is confined in a space, a person working in the space would NOT experience which of the following symptoms?
1. Drowsiness
2. Headache
3. Labored breathing
4. Hallucinations

2-3. What is the difference between aviator's breathing oxygen and industrial oxygen?
1. Industrial oxygen contains impurities
2. Industrial oxygen is stored under high pressure
3. Aviator's breathing oxygen is free of moisture
4. Aviator's breathing oxygen is stored under low pressure

2-4. In the performance of his duties, the ABF utilizes nitrogen to
1. operate portable power tools and equipment
2. test and purge pipe lines
3. extinguish fires
4. inflate liferafts and vests

2-5. What may be considered a serious hazard when compressed air is used?
1. Explosion due to high pressure
2. Asphyxiation when used in a confined space
3. Toxic affect on personnel
4. A fire hazard when used near aircraft fuels

2-6. Normally, where are cylinders of flammable and explosive gases stowed aboard ship?
1. Below deck
2. On the weather deck
3. On the hangar deck
4. In the fire control area

2-7. When compressed gas cylinders are transferred by a crane from the dock to the ships, which of the following lifting devices must NEVER be used?
1. Cradle
2. Electromagnet
3. Rack
4. Platform

2-8. At what temperature and pressure will steam become an almost perfectly dry gas?
1. 739° C at 600 psi
2. 489° F at 250 psi
3. 600° F at 739 psi
4. 739° F at 600 psi

2-9. There are two basic rules related to safety which should be remembered. Never let familiarity breed contempt, and accidents seldom just happen; they are caused.

Learning Objective: Identify types of information contained in maintenance manuals and recognize the definition and use of the COSAL.

2-10. Which of the following is NOT usually included in the first section of a maintenance manual?
1. A discussion of the functions and operations of the equipment
2. A listing of spare parts applicable to the equipment
3. Enlarged views of the entire equipment
4. A general description of the equipment

2-11. What appears on the line with the illustration number of a part illustrated in the detailed sections of a maintenance manual?
1. The correct nomenclature and part number or drawing number
2. The National stock number
3. The page number of the manual
4. The material accountability number

2-12. Which of the following statements decribes a COSAL?
1. It is an allowance list that reflects all the equipment required to store and pump fuel on a particular aircraft carrier
2. It is a parts list prepared by the ships parts control center for all aircraft carriers
3. It is a parts list for a ship's supply department to be used in converting part numbers to stock numbers
4. It is an allowance list that reflects all the equipment that is installed in a particular ship

2-13. Which of the following is NOT contained in part I of the COSAL?
1. Summary of effective allowance parts
2. Index-- Section A
3. Index-- Section B
4. Stock Number Sequence list

2-14. What does Section E of the COSAL list?
1. Forms and publications
2. Storeroom items
3. General use consumables
4. Operating space items

2-15. To assure an accurate and complete COSAL, how must ship's personnel validate the COSAL?
1. By physical comparison of installed components
2. By cross checking the COSAL with the APL and APA list
3. By validating the COSAL with BRASO
4. By requesting validation from NAVSUPSYSCOM

2-16. Upon completion of the inventory aboard ship, to whom is the validation of the COSAL forwarded?
1. SPCC
2. CO
3. 3-M coordinator
4. Air officer

Learning Objective: Identify types of material with cognizant symbols and the definitions of NSA and APA materials, and recognize proper procedures for procuring, inventorying, and stowing material and equipment.

2-17. Which of the following are classed as cognizance symbol "H" materials?
1. Nonsparking tools
2. Portable flight deck cranes
3. Parts for electric motors
4. Cleaning agents

2-18. Nonsparking tools are classified under which cognizance symbol?
1. S-1
2. S
3. H
4. 9G

2-19. To order cognizance Symbol "H" material, to whom should the supply chit be submitted?
1. The Ships Parts Control Center, Mechanicsburg, PA
2. The general stores division of the ship's supply department
3. The general stores division, NAVSEA
4. The cognizant supply depot

2-20. Which of the following information should you include on all requisitions to expedite the delivery of correct replacement parts?
1. The stock number
2. The correct nomenclature
3. The manufacturer's part number
4. All of the above

2-21. Who may sign the DD Form 1348 for the ABF?
1. The air officer
2. The storekeeper
3. The supply officer
4. The 3-M coordinator

2-22. What is meant by NSA material?
1. Material accountable to the Naval Supply Administration
2. Material carried in the Naval Stock Account and paid for from the Naval Stock Fund
3. Material which is not charged against local funds
4. Material procured from naval supply support activities

2-23. What is meant by APA material?
1. Material which is charged to the applicable appropriation when it is initially purchased
2. Aircraft purchases account material
3. Active purchasing account material
4. Aviation purchases account material

2-24. During an annual inventory, the amounts of equipage on hand coded D, E, R, and L are checked against the amounts shown on
1. the COSAL
2. the Master Cross-Reference Listing
3. NAVSUP Form 306 or 460
4. DD Form 1150 (Credit)

2-25. How does a division officer determine that equipage is available and in a serviceable status?
1. By periodic inventories
2. By checking the custody cards
3. By checking the maintenance and replacement schedule
4. By requesting the status from SPCC

2-26. Where should emergency material and equipment NOT be stowed?
1. In unusually shaped compartments
2. In bins and racks and lashed securely
3. As near as possible to the place where they will most likely be used
4. Behind locked doors even though they are pilferable

Learning Objective: Recognize requirements for, and types of, fuels used in aircraft engines and how the different grades of these fuels are designated.

2-27. What type of engine uses aviation gasoline?
1. Ramjet
2. Turbojet
3. Piston
4. Rocket

2-28. Other than the fact that it must be a liquid, what is another basic requirement for aircraft fuel?
1. The capability of high compression
2. The capability of containing heat energy which can be converted into mechanical energy
3. The ability of being light in weight
4. The ability to be stored aboard ship with little risk

2-29. What is the primary concern in formulating aircraft fuels?
1. They must be designed for a wide variety of engine types that operate under particular conditions
2. They must be easy to obtain and store
3. They must be designed for particular engine types that operate under a wide variety of conditions
4. They must be as safe as possible so that they may be stored aboard ship

2-30. Which of the numbers listed below is NOT an octane number?
1. 115/145
2. 100
3. 91/96
4. 80

2-31. In the AvGas grade designation 115/145, the number 115 indicates the
1. performance rating with a rich fuel-air mixture
2. knock rating with a lean fuel-air mixture
3. octane rating with a lean fuel-air mixture
4. octane rating with a rich fuel-air mixture

2-32. Like the number designations of AvGas, the number designations of turbine engine fuels indicate the octane or performance rating of the fuel.

Learning Objective: Recognize characteristics of aviation gasoline and jet fuels including the meaning and effects of volatility, vapor pressure, solvency, freeze points, and flashpoints.

2-33. The tendency of a fuel to evaporate or vaporize is known as its
1. distillation characteristic
2. density
3. intensity
4. volatility

2-34. Refer to figure 3-1 in your textbook. At approximately what minimum temperature does JP-5 give off sufficient vapor to become explosive?
1. 0° F
2. 65° F
3. 100° F
4. 140° F

2-35. Which of the following aircraft fuels has the lowest vapor pressure?
1. F-18
2. F-22
3. F-40
4. F-44

2-36. Because of the range of its vapor pressure, JP-4 forms explosive vapors in what temperature range?
1. 10° F to + 80° F
2. 15° F to + 70° F
3. 10° F to + 100° F
4. 5° F to + 45° F

2-37. Because of its solvent properties, aviation gasoline must be delivered through which type of hose?
1. Specially treated flexible plastic hose
2. Impregnated cloth hose
3. Specially designed synthetic rubber hose
4. Hose similar in construction to firehose

2-38. A freezing point of aviation fuel is defined as that temperature at which
1. the gasoline becomes cloudy
2. the gasoline becomes solid
3. the gasoline flow is restricted
4. solid particles begin to form

2-39. The lowest temperature at which a combustible vapor is formed in aviation fuel is called the
1. flashpoint
2. volatility index
3. ignition temperature
4. combustion point

2-40. Refer to table 3-2 in your textbook. Which of the following symbols designates aviation fuel that has the lowest freeze point?
1. F-34
2. F-22
3. F-42
4. F-44

Learning Objective: Identify health hazards and safety precautions associated with the handling and use of aviation fuels, symptoms indicating inhalation of gasoline vapors, and methods of removing gasoline from the skin.

2-41. ABFs are constantly exposed to the hazards associated with aviation fuels and, although explosion and fire are ever present dangers, sickness from vapor inhalation and skin irritation from direct contact are more common.

2-42. Personnel should NOT be permitted to work in spaces where hydrocarbon vapors exceed, by volume, the minimum of
1. 100 ppm
2. 250 ppm
3. 300 ppm
4. 500 ppm

2-43. Before a person is allowed to enter the AvGas stowage tanks, who must certify the tanks are "safe for entry"?
1. Damage control officer
2. Gas-free engineer
3. Air officer
4. Engineering officer

2-44. Areas of the skin that have come in contact with aviation fuel should be bathed thoroughly with
1. soap and water
2. soda and water
3. sodium bisulfate
4. Stoddard Solvent

2-45. With respect to jet fuels and aviation gasolines, which of the following statements is INCORRECT?
1. They present similar health hazards
2. Jet fuels may be used for cleaning purposes, but gasoline may not
3. Jet fuels contain toxic aromatics
4. Gasoline contains tetraethyllead

2-46. Refer to tables 3-2 and 3-3 in your textbook. Which of the following aviation fuels contains tetraethyllead?
1. F-22 only
2. F-22 and F-34
3. F-34 and F-44
4. F-42 and F-44

Learning Objective: Identify different forms of water that may be present in aviation fuels and indicate the capabilities of alcohol as a deicing agent.

In items 2-47 through 2-49 which concern water in aviation fuel, select from column B the definition that is associated with each form of water listed in column A.

A. Forms of Water

2-47. Entrained water

2-48. Dissolved water

2-49. Free water

B. Definitions

1. Water present in the fuel which has NOT been dissolved by the fuel
2. Water which is held in solution and can NOT be separated from the fuel by filtration or mechanical means
3. Free water which is suspended in a fuel sample and which has NOT settled to the bottom of the container

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2-50. The deicing capabilities of alcohol are based on its ability to
1. remain separate from the water in the gasoline and dissolve the ice particles as they form
2. mix with water and form a mixture that will melt ice
3. coat fuel lines, pumps, and carburetors to prevent ice from forming
4. mix with gasoline and assimilate all the entrained water

Learning Objective: Identify the properties, composition, and characteristics of aviation fuel.

2-51. Aviation fuels currently being used consist almost entirely of
1. hydrogen, carbon, and oxygen
2. hydrogen and carbon only
3. hydrogen and oxygen only
4. hydrogen, oxygen, and nitrogen

2-52. The only nonhydrocarbon impurity in aviation gasoline is
1. bromine
2. dye
3. lead
4. sulfur

2-53. What is added to aviation gasoline to reduce knock?
1. Lead and dye
2. Lead and sulfur
3. Lead and bromine
4. Lead and carbon

2-54. Turbine fuel differs from aviation gasoline in that turbine fuel contains
1. more carbon, more hydrogen, and less sulfur
2. more carbon and less hydrogen
3. less carbon and more hydrogen
4. less carbon, more hydrogen, and more sulfur

2-55. The advantages of a fuel containing oxygen are outweighed by the disadvantage of
1. its increased volatility
2. its greater danger in storage and handling
3. its inability to be completely burned by present day reciprocating engines
4. the additional amount required to do a specific job

2-56. Which of the following grades of Avgas would have the LEAST tendency to knock?
1. 74/90
2. 80/87
3. 90/97
4. 100/115

2-57. What will result if a small amount of JP-5 is mixed with 115/145 AvGas?
1. The knock value of the Avgas will be reduced
2. The octane rating of the AvGas will be increased
3. The knock value of the AvGas will be increased
4. The knock value of the JP-5 will be reduced

2-58. Refer to table 3-3 in your textbook. At the present time, the largest amount of lead is found in which of the following types of aviation fuel?
1. JP-4
2. JP-5
3. 80/87
4. 100/130

2-59. Bromine is combined with tetraethyllead in aviation gasolines for the purpose of

1. creating a lead oxide that is easily expelled from the cylinder with the exhaust gas
2. reducing the toxicity of the exhaust gas
3. increasing the knock value of the AvGas
4. reducing the amount of deposits left in the engine when the fuel is burned

2-60. Dye is added to military gasoline to indicate the gasoline's

1. age
2. grade
3. percentage of tetraethyllead content
4. percentage of bromine content

2-61. Which aviation fuel can be identified by its purple color?

1. JP-4
2. JP-5
3. 80/87
4. 115/145

Learning Objective: Recognize characteristics of the different types of fuels, causes and effects of aviation fuel contamination, and methods of preventing this contamination.

2-62. Why is water, as a contaminant of aviation fuels, so dangerous to the operation of modern-day aircraft at high altitudes?

1. The vapor pressure of the fuel is increased
2. Ice formation restricts metering orifices
3. The octane number of the fuel is reduced
4. The flash point of the fuel is reduced

2-63. What is the most likely result of aviation gasoline becoming contaminated by jet fuel?

1. It will clog the filters
2. It will clog the fuel metering orifices
3. It will increase the gasoline's antiknock qualities
4. It will decrease the gasoline's antiknock qualities thereby affecting engine performance

2-64. If a flight of aircraft aboard ship are fueled from a contaminated stowage tank, what must be done?

1. If gross contamination is found, all aircraft must be defueled and refueled from a stowage tank which is NOT contaminated
2. Samples must be taken from each aircraft and sent to the nearest laboratory to determine if the aircraft's fuel is contaminated
3. Flight operations are allowed to continue; however, upon completion all aircraft must be checked for contamination
4. Flight operations are suspended, and all aircraft engines must be torn down by maintenance personnel to determine the extent of damage

2-65. A jet engine must be able to handle how much more contamination than a reciprocating engine?

1. 1-3 times as much
2. 6-7 times as much
3. 8-10 times as much
4. 12-18 times as much

2-66. With respect to mixed fuels, which of the following statements is INCORRECT?

1. When jet fuel is mixed with AvGas, the antiknock quality of the AvGas is reduced
2. Even though a large quantity of AvGas is mixed with a jet fuel, it will not seriously affect the performance of the engine
3. It takes only a small percentage of jet fuel to be mixed with AvGas to seriously reduce the efficiency of the engine
4. When AvGas is mixed with jet fuel, the flashpoint of the jet fuel is decreased

2-67. As measured by the AEL Mk I free water detector, what is the maximum amount of free water which may be contained in a fuel and still be delivered to an aircraft?

1. 1 ppm
2. 5 ppm
3. 3 ppm
4. 6-7 ppm

2-68. Problems concerning the effects, prevention, and control of contamination intensify as the rate of fuel consumption increases.

2-69. A filter/separator rated at 225 gallons per minute when used to process AvGas will do which of the following when it is used to process jet fuel?

1. It will process less fuel per minute
2. It will process more fuel per minute
3. It will filter out more foreign matter but will separate less water
4. It will filter out less foreign matter but will separate more water

2-70. Air in the tanks, pumps, and lines of fuel systems increases contamination of the fuel because the moisture it contains

1. clogs the filters
2. increases the fuel's viscosity
3. increases the fuel's specific gravity
4. increases the formation of rust

2-71. The most important single factor in assuring that uncontaminated fuel will be delivered to all aircraft is

1. the proper use of fuel decontamination equipment
2. an awareness of the contamination problem by the ABF
3. the cautions to be exercised in the correct fuel for each aircraft engine
4. careful inspection and sampling procedures for detecting contamination

Assignment 3

Aviation Fuels Contamination; High-Capacity Gasoline Systems

Text: Pages 62 - 86

Learning Objective: Identify visual standards required for aviation fuel, and indicate types and composition of related contamination, their sources, and distinguishing characteristics.

3-1. What visual standards must aircraft fuel meet to be acceptable?
1. Clear and free of water
2. Colorless and free of sediment
3. Free of sediment, sparkling, and cloudless
4. Sparkling, clear, and colorless

3-2. Which of the following statements is correct relative to the formation of a cloud of precipitation in a fuel?
1. The cloud is unimportant, and the fuel is acceptable
2. Even a slight cloud makes fuel unacceptable
3. New elements are required in the filter/separator
4. Water and emulsion should be stripped from the source tank

3-3. What are the most common types of sediment found in fuel?
1. Paint and rubber
2. Metal and rust
3. Rust and sand
4. Sand and metal

3-4. To distinguish between coarse and fine particles of sediment, a division is made at
1. 1,000 microns
2. 100 microns
3. 10 microns
4. 5 microns

3-5. Although invisible to the naked eye when separated, microscopic particles of foreign matter grouped together in a fuel sample appear as a
1. speck or spot
2. slight haze
3. residue on the sides of the container
4. separate layer

3-6. Microbiological growths which appear in aviation fuels are described as being
1. dark colored, fibrous, and stringy
2. dark colored, fibrous, and ball-shaped
3. straw colored, mayonnaise-like, and stringy

    straw colored, mayonnaise-like, and ball-shaped

3-7. What is the key ingredient for the development and growth of microorganisms in jet fuel?
1. Sand or soil deposits
2. Free water
3. Rust particles
4. Metallic elements

3-8. A naval aircraft flies from its shore base at NAS Roosevelt Roads, Puerto Rico, nonstop to NAS Norfolk. The indicators show that there is nearly as much fuel aboard when the aircraft landed as there was when it departed Roosevelt Roads. This situation illustrates one of the hazards of
1. microbiological growth in the fuel tanks
2. sediment in the fuel
3. emulsions in the fuel and fuel tanks
4. mixed fuels in the fuel tanks

Learning Objective: Indicate types and composition of aviation fuel contamination, and identify their sources and distinguishing characteristics.

3-9. An inverse emulsion must contain a stabilizing agent. Which of the following would NOT be considered as a stabilizing agent?
1. Red or black rust
2. Surface active agents
3. Microbiological growth
4. Water

3-10. When combined with a stabilizing agent, which of the following mixtures is considered a fuel-in-water emulsion?
1. 20 parts fuel, 80 parts water
2. 40 parts fuel, 60 parts water
3. 60 parts fuel, 40 parts water
4. 80 parts fuel, 20 parts water

3-11. Which of the following would NOT be considered a surfactant in an aviation fuel?

1. Corrosion inhibitors used in the fuel to prevent corrosion of pipelines and tanks
2. Cleaning compounds used to clean fuel stowage tanks
3. Treating materials used in the fuel refining process
4. Sulphur inherent in the fuel

3-12. Indicate in the spaces provided if each statement concerning surfactants is true or false, then select the alternative which lists the true statements.

___A. A surfactant in fuel causes the fuel and any water that contacts it to mix more easily and to become harder to separate

___B. It is not necessary for surfactants to be present for microbiological accumulation, but they may promote its growth by aiding the mixing of fuel and water

___C. Surfactants are added to fuel for the purpose of hastening the removal of water

1. A and B
2. A and C
3. A, B, and C
4. B and C

3-13. Although surfactants are the most common type of contamination found in aviation fuels, their presence in fuel is easily detected and they can usually be eliminated before any damage to the fuel or fuel system occurs.

3-14. Which mechanical method, if any, can be used to separate commingled jet fuels?

1. Settling
2. Filtering
3. Centrifuging
4. None; they cannot be separated

Learning Objective: With regard to detection of contaminated fuel, identify types of and procedures for taking samples, including equipments used.

In items 3-15 through 3-18, select from column B the type of fuel sample associated with each description in column A.

A. Descriptions

3-15. A sample taken at or near the discharge point of a hose immediately before and during the first few minutes of pumping

3-16. A sample consisting of one container from a large stock of packaged fuel of the same grade and age

3-17. A sample containing a blend of individual samples from several tanks that contain the same type of product being sampled

3-18. A sample representative of all fuel between the drawoff level and the top surface level of a tank

B. Sample Types

1. Composite
2. All-level
3. Line
4. Representative

3-19. Which of the following statements relative to the proper procedures for sampling petroleum products is INCORRECT?

1. If it is impractical to take a required sample from a connection in a vertical pipe, the sample should be taken from a horizontal pipe at a point halfway between the top and bottom of the pipe
2. Before taking a sample with a clean sampling container, the container should be rinsed and flushed several times with the fuel to be sampled
3. In order to obtain a truly representative sample, the sampling container should be filled to capacity
4. When sampling fuel delivered to aircraft, the sample should be taken from the fueling hose nozzle during actual fueling operations

3-20. Fuel sample containers, whether large or small, if used for sediment and water tests, must be made of

1. glass and have metal tops
2. nonmetallic material and have glass linings
3. glass and have nonmetallic tops
4. metal and have glass linings

3-21. Which of the following items of information is NOT required on the identification of a fuel sample?
1. The method which was used to obtain the sample
2. The name of the person who took the sample
3. The location in the fuel system from which the sample was taken
4. The date that the sample was taken

3-22. Assume that a representative sampling of a large stock of packaged fuel revealed contamination sufficient to make the entire supply suspect. Further samples were taken, labeled, and sent to be tested. The first sample taken was a
1. composite sample, and the others were routine samples
2. routine sample, and the others were special samples
3. routine sample, and the others were composite samples
4. special sample, and the others were routine samples

3-23. When making a visual inspection of a fuel sample, an ABF should use a
1. round, clear-glass bottle at least 1 quart in size
2. tubular, clear-glass beaker at least 1 pint in size
3. square, 1-gallon laboratory beaker
4. round, clear-glass jar at least 1 gallon in size

3-24. After you visually check a fuel sample for correct color and water content, you should then check it for coarse particles by
1. shaking it vigorously to break loose any previously undetected emulsion
2. whirling it rapidly so that groups of fine particles will be broken up and assimilated into the fuel
3. placing it in a protected area so that the remaining sediment will settle to the bottom of the container
4. whirling it to form a vortex that will force the sediment to the center

3-25. If contamination is found in a fuel sample, another sample should be drawn into a thoroughly cleaned container and the visual inspection repeated.

3-26. Why are two Millipore filters used when a test is conducted?
1. To speed up filtration only
2. To increase accuracy only
3. To eliminate any fuel color effect and increase accuracy
4. To speed up filtration and eliminate any fuel color effect

3-27. The light intensity is controlled by a constant voltage transformer and a
1. thermostat
2. photovoltaic cell
3. rheostat
4. hydrostat

3-28. When the contaminated fuel detector is used, what is the size of the polyethylene sample bottle?
1. 8 oz
2. 16 oz
3. 24 oz
4. 32 oz

3-29. Which component is used to drain the fuel from the flask after it has been pumped through the filters?
1. Drain pump
2. Receiver
3. Tygon tubing
4. Filter holder

3-30. When the light transmission is measured through a Millipore filter, what is the recommended number of minutes that the light source should be warmed before it is used?
1. 1 to 2 min
2. 2 to 3 min
3. 3 to 4 min
4. 4 to 5 min

3-31. What is the main function of the AEL Mk 1 detector?
1. To detect free water
2. To detect entrained water
3. To detect emulsified water
4. To detect treated water

3-32. During the procedure of measuring the amount of free water in AvGas using the AEL Mk 1, when should you turn on the vacuum pump?
1. Immediately before plugging in the ground wire jack
2. Immediately after shaking the bottle containing the sample for 30 seconds
3. Immediately before placing the detector pad on the contaminated fuel detector base
4. Immediately after filling the sample bottle to the 500-cc mark with fuel to be tested

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Learning Objective: Identify proper materials and procedures for cleaning shipboard aviation fuel tanks.

3-33. Why is it best to clean JP-5 stowage and service tanks at sea rather than in port?

1. Because of the additional precautions necessary in port to prevent the wash water from polluting the harbor and the ease with which the wash water can be disposed of at sea
2. Because of the availability of additional manpower from other divisions to aid in the washdown while at sea
3. Because additional manpower is needed in port
4. Because the crew would not have time to clean the tanks in port and perform other needed maintenance

3-34. Steaming of the JP-5 stowage and service tanks and the use of chemical methods are expressly prohibited because these processes

1. can disguise emulsions clinging to the sides of the tanks by changing their surface appearance
2. might create a hazard when combined with explosive vapors that might remain in the tanks
3. can damage the protective coatings in the tanks and can make the filter/separators ineffective
4. might leave residues which would be harder to remove than the original contamination

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Learning Objective: Regarding fuel filtering and monitoring devices, identify operating principles, purposes, relative locations, and schedules/procedures for testing and replacing, including the reasons and procedures for disposing of filter elements and sludge removed from fuel systems.

3-35. What causes water in fuel to go to the sump of the filter/separator?

1. The droplets of water in fuel are separated into smaller droplets by the coalescer and are forced into the sump by low-pressure air
2. The droplets of water in fuel are brought together by the coalescer, and their weight forces them into the sump
3. The droplets of water in fuel are brought together by the coalescer and are forced into the sump by low-pressure air
4. The droplets of water in fuel are separated into smaller droplets by the coalescer so they can drift into the sump through the filter passages

3-36. Which of the following statements concerning the location and purpose of the separator stage of the fuel system filter/separator is correct?

1. It is located upstream of the coalescer stage to remove large solid particles before the fuel enters the coalescer stage
2. It is located upstream of the coalescer stage to remove large droplets of water before the fuel enters the coalescer stage
3. It is located downstream of the coalescer stage to remove any water droplets that may have been carried along with the fuel without settling
4. It is located downstream of the coalescer stage to remove any small solid particles that were not removed by the coalescer stage

3-37. What is the basis for the replacement schedule for coalescer elements of the transfer filter/separator?

1. The amount of fuel pumped through the filter only
2. The hours of operation only
3. The number of gallons of fuel pumped through the filter/separator and the pressure drop limit listed in the instruction sheet contained in each element packing container
4. The type of elements installed and the hours of operation

3-38. Why is the centrifugal purifier so highly efficient?

1. Because contaminants and filtered fuel are continually in motion
2. Because filtering is as efficient at the end of a run as at the beginning
3. Because accumulated solids are not stored within the purifier
4. Because it removes the water faster than other methods

3-39. What test should you perform daily to maintain a constant check on coalescer element efficiency in the JP-5 service filter?

1. Examine fuel samples taken from the water filter sump and filter discharge section drain for evidence of dirt and excessive water
2. Observe the pressure drop in the separator elements at a fixed flow rate through the coalescer elements
3. Increase the flow rate through the filter beyond the optimum flow rate while observing the pressure levels in the coalescer elements
4. Check the pressure in the coalescer elements while fuel is being pumped from one quadrant to another

3-40. When changing service filter elements, coalescer elements from one manufacturer may be used with separator elements from another manufacturer; however, all elements of each type must be from the same manufacturer.

3-41. In one of the tests to determine filter effectiveness, the coalescer element is submerged in fuel and pressure is applied to the fuel. Which condition indicates a defective element?
1. Droplets of clear water forming on the outlet surface of the element
2. Droplets of clear water clinging to the bottom of the tank
3. A stream of air bubbles rising to the surface of the fuel
4. A cloudy stream of water flowing from the element

3-42. The filter elements and sludge removed from aviation gasoline systems are very hazardous for which of the following reasons?
1. Fire hazard only
2. Presence of lead only
3. Fire hazard and presence of lead
4. Presence of impurities

3-43. At shore activities, how should you dispose of filter elements and sludge removed from aviation gasoline systems?
1. By burning them in an approved burn pit
2. By keeping them wet with water until they are buried under two or more feet of earth in a controlled access area
3. By attaching weights and sinking them in the nearest stream or body of water which is at least 50 feet deep
4. By turning them into the nearest holding facility

3-44. When at sea, filter elements and sludge removed from jet fuel systems should be weighted and sunk in deep water. How many miles from the nearest land must the ship be before disposing of the elements?
1. 25 mi
2. 50 mi
3. 75 mi
4. 100 mi

3-45. Assume that the fuse sensing elements in a fuel monitor swell to the point where the flow of fuel ceases due to the pressure of the spring-loaded piston at the end of the tube. Which of the following statements concerning this situation is correct?
1. The fuel monitor is functioning normally, and the fuel is contaminated
2. The upstream filter is malfunctioning
3. The fuel monitor is malfunctioning, and the piston spring needs readjusting
4. The upstream filter is functioning normally, and the fuel is contaminated

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Learning Objective: Indicate design features and operating characteristics/principles applicable to the aviation gasoline stowage tanks located aboard aircraft carriers.

3-46. What class of carrier does NOT have an inner tank in its set of AvGas saddle stowage tanks?
1. LPH-2
2. CVS-34
3. CVA-41
4. CVA-59

3-47. Refer to table 5-1 in your textbook. Which class carrier is provided with the largest capacity for aviation gasoline?
1. LPH-2
2. LPD-3
3. CVA 59
4. CVA 63

3-48. AvGas is removed from the aviation gasoline tanks aboard carriers by
1. sea water being pumped into the tanks
2. the AvGas pumps on the first platform
3. the elevated loop
4. the N_2 pressure in the cofferdams

In items 3-49 through 3-52, select from column B the number, capacity, and location of the main service filters found in the gasoline system of each class carrier listed in column A.

	A. Carrier Class	B. Filters
		1. Two 400-gpm at the pumproom level
3-49.	CVA 63	
3-50.	CVA 59	2. Two 800-gpm at the 3rd deck level
3-51.	LPD	
3-52.	LPH	3. One 300-gpm at each service station
		4. One at the 3rd deck level, the capacity of which is dependent upon the size of the distribution riser

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3-53. Which type of aviation gasoline stowage system is used on all aircraft carriers?
1. Hydraulic
2. Pneumatic
3. Inert gas
4. Mechanical

3-54. The hydraulic gasoline stowage system functions because of which of the following principles?

1. Gasoline is heavier than sea water
2. Gasoline is equal in weight to sea water
3. Gasoline is lighter than sea water
4. Gasoline is capable of mixing with sea water

3-55. If the gasoline in the stowage tanks is NOT replaced by sea water, which of the following will occur?

1. The tanks will become fouled
2. The trim of the ship will be affected due to less weight in the keel
3. Explosive vapors will form in the tanks
4. Inert gas will escape into the empty tanks from the cofferdams

3-56. Which of the following conditions provide the greatest possible safety for the stowage of AvGas within the saddle-type aviation stowage tanks?

1. By improving the strength of the ship's hull around the tanks
2. By keeping AvGas away from other fuels
3. By ensuring the tanks are full of liquid at all times
4. By ensuring the tanks are surrounded by sea water

3-57. A set of saddle-type gasoline stowage tanks consists of a

1. drawoff tank, an inner tank, and a pumproom tank
2. gravity tank, an inner tank, and an outer tank
3. drawoff tank, an inner tank, and an outer tank
4. gravity tank, an inner tank, and a pumproom tank

In items 3-58 through 3-61, select from column B the component of the AvGas stowage system that is associated with each statement listed in column A.

A. Statements	B. Components
3-58. It is connected to and completely envelopes the drawoff tank	1. Outer tank 2. Inner tank
3-59. It is the first to be filled and the last to be emptied	3. Drawoff tank
3-60. It contains the sea water supply riser	
3-61. It is provided with a gage located in the pumproom with a fixed red pointer indicating maximum allowable tank-top pressure	

Learning Objective: Indicate the purposes and operating principles/procedures applicable to the cofferdams (including components) and diffusers surrounding the stowage tanks, and compute associated problems dealing with inert gases.

3-62. How do the cofferdams protect the AvGas stowage tanks?

1. By charging the cofferdams with a mixture of CO_2 and nitrogen
2. By providing fire and explosive protection systems within the cofferdam
3. By providing fixed eductors to pump the AvGas from one tank to another
4. By providing a void to collect any leakage and charging them with nitrogen

3-63. How is the percent of inertness of the cofferdam determined?

1. By measuring the amount of oxygen in the cofferdam only
2. By measuring the amount of nitrogen in the cofferdam only
3. By measuring the amount of oxygen and nitrogen in the cofferdam
4. By measuring the amount of AvGas vapor and oxygen in the cofferdam

3-64. What percent oxygen is in the air of a cofferdam when 75 percent inertness is indicated?
1. 1.575
2. 5.25
3. 15.75
4. 52.5

3-65. What is the percent of inertness when the air in a cofferdam contains 10.5 percent oxygen?
1. 10.5
2. 40.0
3. 50.0
4. 89.5

3-66. After a cofferdam has been charged with nitrogen until the required percent inertness is obtained, the vents should be closed and the pressure in the cofferdam allowed to build up to
1. 1/2 psi
2. 50 psi
3. 15 psi
4. 4 psi

3-67. The use of CO_2 to inert the cofferdams requires which of the following precautions?
1. Care must be taken that the inertness does not exceed 50 percent when using CO_2
2. The rate of flow of the CO_2 must be limited as it is released from the cylinders to prevent the valves and connections from freezing
3. The CO_2 must be introduced at a slower rate than nitrogen to prevent the loss of CO_2 through the vent pipe
4. Both 2 and 3 above

3-68. How many static-head liquid-level gages are installed in the cofferdams to indicate the leakage of gasoline?
1. Five
2. Six
3. Three
4. Four

3-69. What procedure should you use to get a reading from a static-head liquid-level gage used to indicate the amount of liquid in the cofferdam?
1. Operate the hand pump on the indicating unit body until the column of red liquid stops rising, then read the volume of liquid in the tank from a scale
2. Operate the hand pump on the indicating unit body until the pointer on the gage stops rising, then read the volume of liquid in the tank from the scale
3. Operate the hand pump on the indicating unit body until the column of red liquid stops rising, then read the amount in gallons from the dial
4. Operate the hand pump on the indicating unit body until the pointer on the gage stops rising, then read the amount in gallons from the dial

3-70. What is the purpose of the eductor installed in each cofferdam?
1. To flush the gravity tanks
2. To remove water from the pumproom
3. To flush the access trunk
4. To remove sea water or AvGas from the cofferdam

3-71. Which of the following statements concerning the operation of the cofferdam eductor is INCORRECT?
1. The discharge from the eductor is routed overboard through a hose valve in the sea water overflow loop
2. The eductor is fitted with four suctions of which only two should be operated at any one time
3. The operating controls for the eductor are located in a watertight box in the gasoline pump room
4. The actuating water for the eductor is provided from the fire main

3-72. How is turbulence controlled when sea water or AvGas enters a stowage tank?

1. By a flapper-type check valve acting as a baffle
2. By a nonvortex bellmouth fitting and splash plate
3. By a perforated cylinder, called a diffuser, mounted on the botton of the tank at the end of the sluice pipe
4. By baffles installed within the tank

Learning Objective: Identify operating characteristics of the aviation gasoline system.

3-73. When the AvGas system is in operation, gasoline is delivered from the stowage tanks to the pumps under a positive pressure which is provided by the independent sea water system. Which of the following is the correct sequence of this pressure transmission through the stowage tanks?

1. Inner tank → drawoff tank → outer tank
2. Outer tank → inner tank → drawoff tank
3. Inner tank → outer tank → drawoff tank
4. Drawoff tank → outer tank → inner tank

3-74. If positive gasoline pressure is NOT maintained in the fuel pumps, why is a difficult situation possibly created?

1. Because of airpockets forming in the piping between the fuel level and the pump
2. Because the fuel pumps may become vapor bound
3. Because of the entry of inert gas into the pumping mechanism
4. Because of the effect on fueling pressure at the nozzle

3-75. Sea water for the hydraulic gasoline stowage system is supplied from the ship's

1. fire main
2. sea water system
3. secondary drainage system
4. salt water service system

Assignment 4

High-Capacity Gasoline Systems

Text: Pages 87 - 119

Learning Objective: Recognize operating characteristics of CVA gasoline systems including functions, arrangements, locations, and procedures for testing and maintaining components and component parts.

4-1. An overflow loop is provided in the line between the sea water pumps and the outer tank to prevent
1. gasoline pressure from increasing beyond tank limits
2. the mixing of gasoline with sea water
3. gasoline vapor buildup
4. sea water pressure from increasing beyond tank limits

4-2. Which of the following statements relative to the stripping system is INCORRECT?
1. The stripping system provides a means to remove sludge and water from the bottom of the drawoff tank
2. The stripping system pump is manually operated and is located in the gasoline pumproom
3. The intake line to the stripping system pump terminates at a point 3/4 inch above the bottom of the tank
4. The discharge from the stripping system pump is piped to the inner tank

4-3. Refer to figure 5-6 in your textbook. Arrange the following components of the sea water system for the correct flow of sea water into the outer tank.
- A. Sea water pump
- B. Sea chest
- C. Sea chest valve
- D. Diffuser
- E. Suction header
- F. Filling line
- G. Discharge header

1. B, C, G, A, E, D, F
2. B, C, E, A, D, F, G
3. B, C, E, A, G, F, D
4. B, C, A, E, F, G, D

In items 4-4 through 4-7, select from column B the component of the sea water system that performs each function described in column A.

	A. Functions	B. Components
4-4.	Indicates tank top pressure of the outer tank	1. Discharge header
		2. Pressure gage
4-5.	Keeps the overflow and vent lines clear under icing conditions	3. Heating coils
		4. Bypass line
4-6.	Allows for thermal expansion and contraction of liquids in the stowage tanks	
4-7.	Supplies sea water from the pumps for the outer tank filling line	

4-8. Which component of the sea water system ensures sufficient pressure at the AvGas pump suction header by preventing a siphoning effect of the overflow pipe?
1. Check valve
2. Vent line
3. Heating coil
4. Leak-off line

4-9. When the pipe blind in the line connecting the drawoff tank AvGas line and the sea water suction header contains an open gage, what operation is taking place?
1. Gasoline is being taken aboard
2. The gasoline stowage tanks are being flushed
3. The gasoline distribution piping is being drained into the stowage tanks
4. The gravity tank is being drained

4-10. What function is served by the valved bypass leak-off line?
1. It indicates any leak from the salt water pumps
2. It indicates any leak (AvGas or sea water) from the tanks
3. It assures that the tanks will always be filled with liquid
4. It assures a sharp cleavage line between the AvGas and sea water

Items 4-11 through 4-13 refer to the Allis-Chalmers (4 x 4 KSHA) sea water pump.

4-11. The designation 4 x 4 KSHA means that the pump has a
1. 16-inch suction and a 4-inch discharge
2. 16-inch suction and a 16-inch discharge
3. 4-inch suction and a 4-inch discharge
4. 4-inch suction and a 4-inch discharge

4-12. The coupling end bearings and the outboard end bearings are single- and double-row ball bearings, respectively, which absorb radial loads on the shaft, with the outboard bearing also absorbing the shaft thrust.

4-13. What retains the stuffing box packing that surrounds the sea water pump shaft?
1. An O-ring and a seal ring
2. Two O-rings
3. Five semimetallic packing rings
4. A bushing and a split gland

4-14. The pump room and motor room are separated by a bulkhead. Which component is responsible for creating a seal between the motor and pump?
1. Packing gland
2. Stuffing box
3. Clamps
4. Metal shield

4-15. The purpose of the seal ring, which is located in the stuffing box of sea water pumps, is to
1. provide a space for the discharge of water leakage from the area around the pump shaft
2. provide a space for the entrance of water to prevent overheating of the packing and shaft
3. retain the packing in the stuffing box
4. retain lubricant around the pump shaft

4-16. In the Weil sea water pump, the high-pressure water on the discharge side of the pump is prevented from returning to the inlet side by the
1. suction plate
2. bronze casing ring
3. wearing rings
4. volute shaped casing

4-17. The plane of cleavage in the inner tank of the gasoline stowage tank is the
1. lower level of travel of the upper float
2. upper level of travel of the upper float
3. level when the gasoline floats on the sea water
4. upper level of sea water when there is no gasoline in the inner tank

4-18. Refer to figure 5-9 in your textbook. Which of the following statements relative to multiple step gages is correct?
1. They consist of a series of transmission units used in stowage tanks to measure the cleavage line
2. They are actuated by floats that will float on AvGas
3. They are used in AvGas stowage tanks because all tanks require more than a single transmission unit
4. They are actuated by floats that will sink in sea water

4-19. What procedure is used to prevent sea water from entering the drawoff tank during normal pumping operations?
1. The inner tank indicator is set to read empty when fuel equal to 5 percent of its capacity is still in the tank
2. The inner tank indicator is set to read empty when fuel equal to 5 percent of the AvGas stowage tank's capacity is still in the drawoff tank and inner tank
3. An ABF monitors a bull's sight glass and secures the tanks when sea water appears in the glass
4. An ABF monitors the inner and outer tank multiple step cleavage gages

4-20. To what maximum percent of their total capacity may the AvGas stowage tanks be filled?
1. 100
2. 95
3. 80
4. 75

4-21. Which of the following is the correct flow of AvGas when the service pumps are running?
1. Inner tank → drawoff tank → service pump → common header → fueling station
2. Drawoff tank → suction header → riser → service pump → common header → fueling station
3. Drawoff tank → suction header → service pump → common header → riser → fueling station
4. Inner tank → drawoff tank → suction header → recirculating line → service pump → common header → fueling station

4-22. What prevents the service pumps from overheating when AvGas is being drawn from the tanks but NOT pumped out at the fueling station?
1. The admission of AvGas through a recirculating line
2. The activation of a pressure switch during zero demand
3. The circulation of salt water through the pump cooling system
4. The circulation of fresh water through the pump cooling system

4-23. When are the pump suction header and the discharge header cross-connected to bypass the service pumps?
1. When defueling aircraft only
2. When filling the stowage tanks only
3. When draining the distribution piping or defueling aircraft only
4. When filling the stowage tanks, defueling aircraft, or draining the distribution piping

4-24. Why must the entire mechanical seal be replaced whenever a service pump is opened for inspection or whenever a leak occurs?
1. Because a positive lubricant seal must be maintained
2. Because the bellows will not reseat once it has been removed and no part of the seal can be repaired after it has been damaged
3. Because an undersize seal must be used due to shaft wear
4. Because some of the used parts must be inspected

In items 4-25 through 4-28, select from column B the component of the regulating valve that performs each function listed in column A.

A. Functions	B. Components
4-25. Accelerates the closing of the regulating valve when the flow is suddenly reduced	1. Pilot valve 2. Venturi
	3. Control valve
4-26. Provides the actual control pressure for the regulating valve	4. Recirculating line
4-27. Prevents full shutoff of the regulating valve when AvGas is not being drawn off at the fueling station	
4-28. Controls the regulating valve	

4-29. Which of the following actions takes place to increase the flow through the automatic pressure regulating system?
1. Low pressure in the throat of the venturi will open the ejector bypass valve and increase the flow
2. Low pressure in the throat of the venturi will allow the loading pressure in the regulating valve to dump, opening the regulating valve and increasing the flow
3. High pressure in the throat of the venturi will force the regulating valve open and increase the flow
4. High pressure in the throat of the venturi will prevent the loading pressure in the regulating valve from dumping, opening the regulating valve and increasing the flow

4-30. Any pressure changes in the AvGas distribution line are sensed first in which part of the pressure regulating system?
1. Pilot valve
2. Regulating valve
3. Venturi
4. Globe valve

4-31. What is accomplished when the wheel on the positive stop valve is turned counterclockwise?
1. The valve plug is unseated and raised
2. The valve is rotated open only
3. The valve is rotated closed only
4. The valve plug is lowered and seated

4-32. What is accomplished when the wheel on the positive stop valve is turned clockwise?
1. The valve plug is seated
2. The valve is rotated closed
3. The valve is rotated open
4. The valve plug is unseated

4-33. The double wall piping that serves to collect any leakage from the inner pipe is inerted with nitrogen at 5 to 10 psi. What is indicated if this pressure increases to 13 psi?
1. A defective nitrogen regulating valve on the pressure reducing panels
2. A nitrogen leak in the inner pipe
3. An AvGas leak from the inner pipe
4. An AvGas leak in the outer pipe

4-34. The filter/separator unit is equipped with a captivated float and float control valve which control the operation of which components?
1. The fuel discharge valve and the water drain valve
2. The water level gage and the fuel discharge valves
3. The fuel discharge valve and the water inlet valve
4. The water inlet valve and the water drain valve

4-35. Which of the following statements relative to the function of the filter/separator is correct?

1. The separator element removes all the water, and the coalescing element removes all the solid contaminants
2. The separating element filters 98 percent of the solid contaminants and 100 percent of the entrained water, and the coalescing element removes any remaining solids or water that did not settle in the fall-out chamber
3. The coalescing element removes all the water, and the separator element removes all the solid contaminants
4. The coalescing element filters 98 percent of the solid contaminants and coalesces 100 percent of the water, and the separator element removes any remaining solids and the coalesced water that did not settle in the fall-out chamber

4-36. Assume that the float of the float control valve assembly in the filter/separator unit moves from the raised position to the horizontal position. How does this action affect the operating positions of the fuel discharge valve and the water drain valve?

1. The fuel discharge valve opens, and the water drain valve closes
2. Both the fuel discharge valve and the water drain valve close
3. The fuel discharge valve remains in its original closed position, and the water drain valve opens
4. The fuel discharge valve opens, and the water drain valve remains in its original open position

4-37. Since the only known method of checking the automatic water drain control is to introduce clean sea water into the filter/separator, which set of conditions must exist in order to test the system properly?

1. Sea water pressure greater than fuel pressure; water visible in sump sight glass, water discharge valve cycles once each 5 minutes
2. Sea water pressure greater than fuel pressure; water visible in sump sight glass, water discharge valve cycles once per minute
3. Sea water pressure less than fuel pressure; water visible in sump sight glass; water discharge valve cycles once per minute
4. Sea water pressure greater than fuel pressure; actuating line, filter removed; all separator elements replaced

4-38. Assume that after observing the operation of the water drain valve you close the water drain line and notice that within three minutes the automatic slug control valve at the filter/separator sump discharge closes. From this you determine that the slug control valve is

1. malfunctioning
2. functioning as it should under the circumstances
3. not functioning normally because of a malfunction of the automatic water drain valve
4. not functioning normally because the water flow rate has not been altered from the drain valve test

4-39. Assume that there is the possibility of an aircraft fire spreading to a flight deck fueling station. The station in danger can be isolated by the use of the

1. plug-type cutout valve in the pumproom
2. station isolation globe valve in the pumproom
3. station isolation globe valve in the distribution riser at the main deck level
4. plug-type cutout valve in the distribution riser at the main deck level

4-40. Indicate in the spaces provided if each of the statements regarding the AvGas Cla-Val station is true or false, then select the alternative which lists the choices that are true.

_____A. When the low voltage control circuit is interrupted, the magnetic amplifier serves to eliminate the possibility of sparks

_____B. The hose reels associated with the station are electrically operated by the 440-volt explosion-proof motor

_____C. When the fueling hose ground is broken, the two-way valve reverts to the defueling position

1. A and C
2. A, B, and C
3. A and B
4. B and C

4-41. The two globe valves of the Cla-Val station are equipped with reinforced and supported diaphragms. These diaphragms serve to

1. overcome spring pressure to open both valves
2. overcome spring pressure to close both valves
3. open the fueling valve against spring pressure and close the defueling valve
4. open the defueling valve against spring pressure and close the fueling valve

4-42. The operation of Cla-Val diaphragms is pressure-protected due to the function of the
1. pilot valve
2. valve cover chamber
3. pilot valve system
4. pressure relief control valve

4-43. How is constant fuel delivery pressure maintained in the Cla-Val station?
1. The constant adjustments of the globe valve adjusting screw by the operator balance spring force aginst fuel pressure
2. The force of the compressed valve spring overcomes the delivery pressure of the fuel
3. The pressure of the flowing fuel overcomes the force of the valve spring
4. The pressure under which the fuel is delivered is balanced against the pressure exerted by the control valve compression spring

4-44. The Wheeler fueling station differs from the Blackmer station in that the priming pumps are driven by a separate electric motor.

4-45. How can gasoline leakage past the mechanical seals of the defueling pump bearings be detected without partial disassembly of the pump?
1. Telltale drain holes are provided under each bearing so leakage can be detected
2. Each seal has a telltale slot so the seal can be observed while the equipment is running
3. There is a sight glass installed in the seal housing so that any leakage can be seen
4. All of the above

4-46. Assume that the Blackmer station has been positioned to fuel. Since the four-way valve can NOT be repositioned with the circuits closed, how can it be reversed in the event of an emergency?
1. By manually breaking either of the electrical circuits
2. By breaking the station-to-aircraft ground
3. By manually causing the latch which holds the control to be released
4. By manually breaking both electrical circuits and repositioning the lever

4-47. The overwing defueling rate when using a 2 1/2-inch collapsible hose at a Blackmer fueling station is approximately
1. 25 gpm
2. 35 gpm
3. 75 gpm
4. 100 gpm

4-48. When receiving AvGas aboard, what pressure must the tanker maintain in order to force the sea water out through the overflow loop?
1. 10 to 20 psi
2. 20 to 30 psi
3. 30 to 40 psi
4. 40 to 50 psi

4-49. Which of the following is NOT a normal use for the portable eductor?
1. Draining sea water that cannot be removed by the sea water pumps from the stowage tanks
2. Removing drainage water from the cofferdams
3. Draining sea water from the flushing lines
4. Removing drainage from the AvGas pumproom

Learning Objective: Recognize operating characteristics and purposes of LPH AvGas and AutoGas systems, including functions and arrangement of system components and procedures for inerting protective systems.

4-50. Cleaning the LPH AvGas system of air and vapor prior to filling the tanks entails the utilization of the sea water pumps and which additional components?
1. Inert gas and a vent to the atmosphere
2. Inert gas and the overboard discharge line
3. The AvGas pumps and a vent to the atmosphere
4. The AvGas pumps and the overboard discharge line

4-51. As in the CVA AvGas systems, the LPH AvGas system requires the AvGas delivered to the ship to be under enough pressure during filling to cause the sea water in the stowage tanks to be discharged through the overboard discharge line.

- Like the AvGas systems of the CVA, the LPH system utilizes sea water under pressure to force the gasoline through the tanks to the AvGas pump suction. The pressure is provided by the flow from the sea water pumps acting against the resistance of the liquid in the tanks.

4-52. The sea water pressure, which must NOT exceed the tank top pressure limit but must be sufficient to provide a positive pressure to the AvGas pumps, is controlled by the

1. height of the overboard discharge line
2. common discharge header
3. sea chest pumps
4. sluice pipes

4-53. How does the LPH Cla-Val station differ from the CVA Cla-Val station?

1. The CVA has a filter installed at each station
2. The LPH has a filter installed at each station
3. The CVA has supply riser filters that serve each station
4. The LPH has pumproom filters that serve several stations

4-54. During the process of inerting the AvGas piping system, when should the flow of inert gas into the piping be stopped?

1. When the reflex glass in the suction header shows that the piping is empty
2. When the stowage tank liquid level gage reads empty
3. When the stowage tank is filled with inert gas
4. When sea water flows out of the venting hose nozzle

4-55. The AutoGas system consists of which of the following configurations?

1. It is surrounded by a separate cofferdam
2. It is surrounded by the same cofferdam as the AvGas tanks and consists of one large tank
3. It consists of an outer, inner, and drawoff tank
4. It consists of an outer and drawoff tank only

4-56. Which of the following statements applies to all LPH AvGas systems and also to some CVA AvGas systems?

1. The cleavage gage is substituted for the water-filled, static-head, liquid-level gage
2. The water-filled, static-head, liquid-level gage is substituted for the cleavage gage
3. Both the cleavage gage and the water-filled, static-head, liquid-level gage are used
4. The cleavage gage and the liquid-level gage are incorporated into a single unit

4-57. To reach the fueling station, AutoGas flows from the outer stowage tank through the

1. common header to the inner tank, to the drawoff tank, and into the AutoGas pump suction
2. standpipe to the drawoff tank, to the service tank, and into the AutoGas pump suction
3. sluice pipe to the drawoff tank and into the AutoGas pump suction
4. sluice pipe to the inner tank, to the transfer filters, and into the AutoGas pump suction

4-58. Which of the following phrases best describes the primary function of the sensing bellows in the water-filled, static-head, liquid-level gaging system?

1. Gasoline pressure indication
2. Gasoline amount measurement
3. Inner tank capacity indication
4. Pressure head difference measurement

4-59. Which component of the sea water system regulates the pressure at the top of the fuel tanks?

1. Pressure reducing valve in the overboard line
2. Relief valve mounted on the discharge side of the sea water pump
3. Overboard line
4. Pressure regulator in the discharge header

4-60. What will result if the AutoGas pump discharge piping recirculating lines become inoperative?

1. The alternate recirculating lines will have to be utilized to maintain the 8-gpm fuel flow
2. The 8-gpm flow will be halted, and suction will be reduced enough to necessitate priming before fuel can be pumped
3. The AutoGas pumps will overheat if they are activated when fuel is not being pumped
4. The pump will automatically stop fueling, and defueling will commence

Learning Objective: Recognize correct procedures for operating and securing AvGas systems when fueling and defueling aircraft and when receiving fuel.

4-61. The LPH AutoGas system is inerted differently from the AvGas system on a CV. How is this accomplished?
1. Inert gas is injected into the system at the AutoGas pumproom
2. Inert gas is injected into the system at the fueling stations
3. Inert gas is injected into the system from the producer room at the cofferdam inlet piping
4. Inert gas is injected into the system from the AvGas pumproom through the distribution piping to the interior AutoGas tanks

4-62. In what order should you take the following steps to properly prepare for fueling aircraft at Cla-Val AvGas stations?
A. Line up the distribution system from the drawoff tank to the station and open each pump recirculating line
B. Start one AvGas main pump and open each pump recirculating line between the venturi and the drawoff tanks
C. When the CO_2 flooding system is in order, release the N_2, close the vent when the system drops to 0 psi, and start the sea water system with one pump
D. Vent the filter and observe the vent sight glass; when gasoline appears, open the vents at the deck fueling station
E. Ground the aircraft and the hose, start the defueling pump, and insert the hose into the aircraft
1. A, B, C, D, E
2. C, A, B, D, E
3. B, A, E, C, D
4. E, A, C, B, D

4-63. After defueling operations are completed, the distribution lines must be filled with
1. air
2. nitrogen
3. gasoline
4. sea water

4-64. What is the prescribed pressure for the inert gas in the distribution piping system after the gasoline has been drained from it?
1. 5 psi
2. 10 psi
3. 25 psi
4. 30 psi

4-65. How can receiving AvGas aborad a carrier be expedited?
1. By establishing the amount of AvGas to be received aboard
2. By reducing the number of tanks to be filled by transferring fuel aft
3. By lining up the valves in the piping to bypass the filter, pressure regulating equipment, and AvGas pumps
4. All of the above

4-66. Where is the N_2 from the stowage tank vented preparatory to filling the tank with AvGas?
1. Through the discharge line loop vent to the atmosphere
2. Through the overboard discharge line to the sea
3. Through an atmospheric vent into the cofferdam
4. Through the 1 1/2-inch hose into a safety can

4-67. What is the pressure of the nitrogen used to drain back the gasoline piping to the stowage tank?
1. 10 psi
2. 15 psi
3. 20 psi
4. 25 psi

4-68. Which of the following conditions is correct concerning an emergency breakaway when receiving AvGas aboard?
1. The span wire is parted with an axe
2. The span wire is released by tripping the pelican hook
3. The hose must be released by releasing the pelican hook
4. The connecting lines are released by means of a quick-release lever

Learning Objective: Identify record keeping information and publications containing safety precautions.

4-69. Which of the following publications is a complete safety reference dealing with AvGas stowage?
1. NAVSHIPS Manual, Chapter 9150
2. NAVSHIPS Technical Manual, Chapter 15
3. NAVSHIPS Manual, Chapter 92
4. NAVSHIPS Technical Manual, Chapter 9920

4-70. Which of the following entries should NOT be included in the AvGas pumproom log?

1. The pressure in the lube oil tanks at the end of each day
2. The amount of gasoline in the tanks at the beginning and end of each day
3. The cofferdam pressure and degree of inertness of the N_2 or CO_2
4. Any discrepancies noted or unusual conditions in the pumping machinery

Assignment 5

High Capacity JP-5 Systems

Text: Pages 120 - 149

Learning Objective: Indicate design changes that took place in the high-capacity fuel systems aboard aircraft carriers resulting from the introduction of jet aircraft, and identify characteristics of the systems.

5-1. When jet engines were developed to operate on JP-5 fuel, what tank changes were made?
1. Two forward and two aft wing stowage tanks were converted to JP-5 service tanks, and the starboard saddle tanks were returned to AvGas stowage
2. The four JP-5 wing stowage tanks were converted to JP-5 service tanks
3. Two JP-5 forward wing stowage tanks and the starboard saddle tanks were converted to JP-5 service tanks
4. The four JP-5 wing stowage tanks and the port saddle tanks were converted to JP-5 service tanks

5-2. How does the fuel system aboard a fleet carrier used for ASW operations compare with the system on the newly constructed CVAs?
1. The carriers used for ASW operations have 3 quadrants for AvGas and one for JP-5 while the new CVAs have 4 quadrants for JP-5 and only limited AvGas facilities
2. The carriers used for ASW operations have 3 quadrants for AvGas and one for JP-5 while the CVAs have 4 quadrants for JP-5 and no provision for AvGas
3. The carriers used for ASW operations have 2 quadrants for AvGas, one for jet mix, and one for JP-5 while the new CVAs have 3 quadrants for JP-5 and one for AvGas
4. The carriers used for ASW operations have 2 quadrants for AvGas and 2 for JP-5 while the new CVAs have 3 quadrants for JP-5 and one for AvGas

5-3. Which of the following statements is correct concerning the fuel systems aboard LPDs and CVAs?
1. There is no difference in capacity
2. All fuel filters are identical
3. The arrangement of the service fuel filters varies
4. Both classes of ships contain the same type of fuel systems

5-4. What features in the different types of JP-5 fueling systems aboard aircraft carriers are practically identical?
1. The pumps and filters
2. The types and number of components
3. The designs and operational procedures
4. The types and location of the components

Learning Objective: Recognize subsidiary systems that make up the CVA JP-5 fueling system, and identify physical locations, design features, operating and maintenance characteristics/procedures, and functions of the system and its related components.

5-5. A CVA JP-5 fueling system is composed of which of the following pumping systems?
1. Filling and transfer only
2. Service and stripping only
3. Stripping and stowage only
4. Stowage, stripping, service, filling, and transfer

5-6. How do JP-5 fueling systems differ from AvGas systems aboard CVAs?
1. JP-5 systems do not use sea water to replace the fuel as it is consumed
2. JP-5 systems use sea water to replace the fuel as it is consumed
3. JP-5 systems must have the tanks full at all times
4. Both 1 and 3 above

5-7. What is the primary function of the hard hose mounted on the motor-operated hose reel?
1. Fueling
2. Defueling
3. Offboard transferring
4. Emergency transferring

5-8. Removing all of the JP-5 from a stowage tank requires the use of a
1. suction and fill tailpipe, a stripping tailpipe, and a hard defueler hose
2. suction and fill tailpipe, a stripping tailpipe, and a power stripping pump
3. stripping tailpipe, a flood and drain manifold, and a hard defueler hose
4. flood and drain manifold, a hard defueler hose, and a power stripping pump

5-9. The solenoid-operated pilot valves control which of the following operations?
1. The fueling of the aircraft
2. The transferring of JP-5 to the service tank
3. The flow of JP-5 from the stowage tank to the overflow tank
4. The filling and transfer system

5-10. The defueling pump transfers fuel from the aircraft to the service tank.

5-11. What system controls the flow of JP-5 into and out of the stowage tanks?
1. The filling and servicing system
2. The servicing and transfer system
3. The servicing and distribution system
4. The filling and transfer system

5-12. What ensures that the overflow from a full stowage tank is directed to the overflow tank and NOT to another stowage tank?
1. Filling and transfer valve
2. Overflow line
3. Meters
4. One-way check valve

In items 5-13 through 5-15, select from column B the item of information that concerns each tank listed in column A.

	A. Tanks	B. Items of Information
5-13.	Overflow	1. Never ballasted
5-14.	Stowage	2. Part of the damage control underwater protective system
5-15.	Emergency	
		3. First to be emptied when transferring JP-5
		4. First to receive JP-5 when the carrier takes on fuel

In items 5-16 through 5-18, select from column B the component that is located in or associated with each of the tanks listed in column A.

	A. Tanks	B. Components
5-16.	Overflow	1. Nonvortex bellmouth
5-17.	Stowage	2. Recirculating line
5-18.	Service	3. Overflow box
		4. Hard hose defueler

5-19. Which of the following is NOT a function of the sounding tube?
1. To detect water
2. To thief a sample
3. To check settling time
4. To check quantity

5-20. Pressure or vacuum is eliminated in JP-5 tanks by
1. equalizer lines
2. recirculating lines
3. air escapes
4. a triple air line enclosed in one cover

- Items 5-21 and 5-22 refer to liquid level indicators.

5-21. Liquid level indicators which weigh the fuel in the tank and give a readout in gallons are frictionless-balance and, because they have no moving parts, retain their accuracy over years of use.

5-22. Which of the following is the correct sequence of pressure transmission in the air model liquid level indicators?

1. Hydrostatic head → equalizer line → air trapped in the tank downpipe → indicating liquid in well → gage glass
2. Hydrostatic head → air trapped in the tank downpipe → equalizer line → indicating liquid in well → gage glass
3. Hydrostatic head → air trapped in the tank downpipe → pressure line → indicating liquid in well → gage glass
4. Pressure line → hydrostatic head → air trapped in tank downpipe → indicating liquid in well → gage glass

5-23. What causes the air model liquid level indicators on the JP-5 tanks to function?

1. The unknown amount of air in the tank balanced against the known amount of static air in the gage
2. The unknown amount of air in the tank downpipe balanced against the known amount of liquid in the U-tube
3. The unknown weight of the liquid in the tank balanced against the known weight of the liquid in the gage
4. The unknown amount of liquid in the tank downpipe displacing a known amount of static air in the presssure line

Items 5-24 through 5-27 refer to the compressed air model (two-tube system).

5-24. What components are provided for accurately reducing the ship's low-pressure air to 45 psi?

1. The duo-snubber and the needle valve
2. The duo-snubber and the pressure gage
3. The reducing valve and the duo-snubber
4. The reducing valve and the pressure gage

5-25. What component prevents a loss of air out of the system in the event the low-pressure air supply is cut off?

1. Rotometer
2. Snubber valve
3. Vent check valve
4. Air check valve assembly

5-26. In the compressed air model liquid level indicator, what is the pressure required for proper operation?

1. 9 psi
2. 7 psi
3. 3 psi
4. 5 psi

5-27. Which of the following components is used to measure the rate of flow through the rotometer of a compressed air model liquid level indicator?

1. Needle valve
2. Piston valve
3. Nylon ball
4. Numbered scale

5-28. With the Gems tank level indicating system (TLI), to what value should the voltage be adjusted?

1. 5 volts dc
2. 10 volts dc
3. 15 volts dc
4. 20 volts dc

5-29. When using the Gems (TLI) system, how far must the float move in order to change the reading at the receiver?

1. 1 in.
2. 2 in.
3. 1 1/2 in.
4. 1/2 in.

5-30. Which of the following statements is correct concerning the use of multiple transmitters to gage a tank?

1. Each transmitter must have a transfer switch installed
2. Each transmitter must be overlapped vertically 9 inches
3. Only two transmitters may be used per tank
4. When using more than one transmitter, they must be mounted top to bottom

5-31. Which of the following statements is correct concerning the floats when using more than one transmitter?

1. The floats never move together
2. The floats may move a short distance together
3. All intermediate transmitters have two floats
4. The bottom float will always be stationary

5-32. Which of the following statements is correct concerning the receivers used with the Gems (TLI) system?

1. Both primary and secondary receivers are identical
2. Only the primary receiver incorporates an alarm system
3. Only one additional secondary receiver may be used
4. The secondary receiver incorporates an alarm system

5-33. Which component is designed to prevent meter fluctuation?
1. Capacitor
2. Potentiometer
3. Slosh damper
4. Sens-Pac

In items 5-34 through 5-36 select from column B the unit described in column A.

	A. Description	B. Units
5-34.	Delays response to the meter	1. Float
		2. Sens-Pac
5-35.	Senses the liquid level	3. Capacitor
5-36.	Requires periodic cleaning	4. Potentiometer

5-37. What is the function of the hand-operated pumps in the service tank pumprooms?
1. To ballast the service tanks
2. To strip the service tanks
3. To strip and consolidate the service tanks
4. To deballast the service tanks

5-38. How close to the bottom can the service tanks be stripped of water and sludge?
1. 0 in.
2. 1/2 in.
3. 3/4 in.
4. 1 1/2 in.

5-39. For what purpose(s) is the JP-5 stowage tank stripping system used?
1. To remove water from the fallout chamber of the transfer filter
2. To consolidate the remaining fuel in the stowage tanks
3. To remove sludge and water from the bottom of the service tanks
4. To provide a means of stripping the tanks by hand

5-40. How many valves in the stowage tank control manifold may be in an open position at the same time?
1. One
2. Two
3. Three
4. Four

5-41. Which of the following areas can NOT receive the discharge from the stripping pumps?
1. The transfer main
2. The contaminated oil tank
3. The ship's main drainage system
4. The control manifold

5-42. Stowage tanks can be deballasted through which of the following?
1. The emergency tank
2. The flood and drain manifolds
3. The overboard discharge valve at third level
4. The overflow tank

5-43. How often must JP-5 stowage tanks be tested for water contamination?
1. Every day
2. Every 7 days and before fuel is to be transferred to service tanks
3. Every 10 days and before fuel is to be transferred to service tanks
4. Every 14 days and before fuel is to be transferred to service tanks

5-44. How often must JP-5 service tanks be stripped for water contamination?
1. Every day
2. Every 7 days
3. Every 10 days
4. Every time suction is applied to the tank

5-45. The basic provision of the 1961 Oil Pollution Act requires that oily waste be pumped overboard at least how many miles from shore?
1. 12 mi
2. 25 mi
3. 50 mi
4. 100 mi

5-46. Except for a filling or transfer operation, the cutout valve on the transfer main of the JP-5 filling and transfer system of a CVA must be kept in what position?
1. In the discharge position
2. In the suction position
3. Open
4. Closed

5-47. The suction and discharge headers of the transfer and service pumps are cross-connected in such a manner that any service pump may be used as a transfer pump in order to accomplish which of the following functions?
1. Emergency use only
2. Offloading JP-5 only
3. Emergency use and offloading JP-5
4. Offloading JP-5 and transferring fuel to fueling stations

5-48. What indicates that the mechanical seals should be replaced in the transfer pumps?
1. Decreased output capacity
2. Decreased output pressure
3. Excessive leakage at the drain holes under the bearing housing
4. Excessive leakage at the drain holes under the mechanical seal housing

5-49. Which of the following indicates the correct flow of JP-5 in the transfer process?
1. Stowage tank → stowage tank pump → purifier → service tank
2. Stowage tank → transfer pump → purifier → service tank
3. Stowage tank → purifier → transfer pump → service tank
4. Service tank → transfer pump → purifier → stowage tank

5-50. Back pressure is maintained in the purifier through the use of a
1. discharge valve
2. relief valve
3. check valve
4. globe valve

5-51. Why is the centrifugal purifier highly efficient?
1. Because separated liquids are kept away from the stored solids
2. Because filtering is as efficient at the end of the run as at the beginning of the run
3. Because contaminants and filtered fuel are continually forced away from each other
4. All of the above

5-52. What characteristic of foreign matter causes it to separate from JP-5 in the revolving bowl of the centrifugal purifier?
1. It is lighter than JP-5
2. It is heavier than JP-5
3. It is less dense than JP-5
4. It is a solid, and JP-5 is a liquid

5-53. After operation, where in the bowl of the centrifugal filter will the solid contaminants be located?
1. At the outer edge of the discs
2. On the bowl wall
3. On the underside of the discs
4. Displaced into the heavy phase outlet

5-54. Which of the following statements is INCORRECT concerning the recirculating lines?
1. The recirculated fuel may be directed to the same tank that suction is being taken from
2. The recirculated fuel may not be directed to the same tank that suction is being taken from
3. Each line is fitted with a stop check valve
4. Each line is fitted with an orifice

5-55. The shaft of the service pump is connected to the shaft of the electric motor by a
1. horizontal shaft
2. flexible coupling
3. chain drive
4. gear drive

5-56. What purpose is served by having the pump-room deck on the same level as the bottom of the service and stowage tanks?
1. Air in the pumping system is eliminated
2. Less effort is required to start the pumps
3. The amount of piping needed in the system is reduced
4. A positive head of liquid is provided for the pumps when the tanks are full

5-57. How are the service pumps primed?
1. By pumping air into them
2. By pumping JP-5 into them
3. By removing the air from them
4. By draining the trapped JP-5 from them

5-58. Which of the following statements is correct concerning the priming system?
1. All priming system components are the same
2. All priming systems are automatic in operation
3. All priming systems are manually operated
4. All priming systems are designed to operate on only one pump

5-59. Which of the following statements concerning the manually operated priming pump is correct?
1. It is manually stopped
2. It is manually started
3. It is a hand-operated pump
4. It is both manually started and manually stopped

5-60. What controls the operation of the automatic-type priming system?
1. The pressure in the priming pump
2. The vacuum in the vacuum tank
3. The position of the float operated priming valve
4. The amount of air in the system

5-61. The function of the Nash priming pump is to remove air from which of the following pumping system components?
1. The manifold only
2. The priming valve
3. The suction line of the pump only
4. Manifold and suction line

5-62. What part of the Nash priming pump keeps the horsepower consumed by the primer to a minimum?
1. The vacuum tank
2. The vacuum relief valve
3. The float-operated priming valve
4. The discharge pressure of the service pump

5-63. What creates the vacuum in the priming pump?
1. The high speed rotation of the service pump
2. The series of pockets constructed in the lobe impeding the liquid flow
3. The counterrotation of the liquid with respect to the rotation of the pump
4. The liquid following the elliptical shape of the lobe when the pump is in operation

5-64. Which service filter valves are controlled by the cleavage plane float?
1. The pilot-operated stop valve and the stop check valve
2. The stop check valve and the slug control valve
3. The slug control valve and the automatic drain valve
4. The automatic drain valve and the pilot-operated stop valve

5-65. How frequently are fuel samples taken from the sump of the service filters?
1. Daily
2. Weekly
3. Biweekly
4. Monthly

In items 5-66 through 5-69, select from column B the item of information most closely associated with each valve listed in column A.

	A. Valves		B. Information
5-66.	Globe	1.	Straight flow with minimum restriction when open
5-67.	Gate		
5-68.	Butterfly	2.	Light in weigh--90° turn to open or close
5-69.	OKADEE	3.	Used on discharge side of pumps--manufactured in three body types
		4.	Uses arrows on the selector and name-plate to indicate the closed position--excessive force is unnecessary to close

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5-70. What piping makes it possible for any of the JP-5 service pumps to supply any of the JP-5 fueling stations?
1. The forward and aft transfer main on the port side
2. The forward and aft transfer main on the starboard side
3. The crossover connection between the forward and aft transfer filters
4. The crossover connection between the port and starboard distribution piping

5-71. What purpose is served by the defueling piping?
1. It is used to defuel the CVA
2. It is used to carry fuel from the defueling station to the service tanks
3. It is used to carry fuel from the fueling station to the stowage tanks
4. It is used to offload fuel

Assignment 6

High Capacity JP-5 Systems, Protective Systems, and the Aviation Lube Oil System

Text: Pages 149 - 168

Learning Objective: Identify operating characteristics and design features of a CVA JP-5 fueling system.

6-1. The newer CVAs have what type of valves in their fueling stations?
1. Blackmer
2. Wayne
3. Hancock
4. Cla-Val

6-2. What is the difference, if any, between a JP-5 Cla-Val station and an AvGas Cla-Val station?
1. A JP-5 Cla-Val station's capacity is higher
2. An AvGas Cla-Val station's capacity is higher
3. A JP-5 Cla-Val station uses larger hose
4. There is no difference; the stations are identical

6-3. Motors which may be used for all defueling pumps are of what type?
1. Explosion-proof and/or spray-tight
2. Electric/hydraulic-operated
3. Spray-tight only
4. Explosion-proof only

6-4. To what position does the solenoid fueling-defueling valve automatically return when it is deenergized after a fueling operation?
1. Deenergized
2. Energized
3. Defueling
4. Fueling

6-5. It is possible to fuel one aircraft and defuel another aircraft at the same fueling station at the same time.

6-6. Fuel for the jet engine test stand is obtained from the
1. service pump in the aft JP-5 pumproom
2. jet engine test stand pump in the aft JP-5 pumproom
3. discharge header on the service pump in the aft JP-5 pumproom
4. transfer pump in the forward JP-5 pumproom

6-7. What is the jet engine test stand fuel pressure, and how is it maintained?
1. A 20-psi pressure maintained by a solenoid-operated pressure-regulating valve on the test stand pump
2. A 30-psi pressure maintained by a solenoid-operated valve on the test stand
3. A 30-psi pressure maintained by a back pressure control valve in the test stand return line
4. A 40-psi pressure maintained by a pressure regulating valve incorporated in the jet engine test stand

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Learning Objective: Indicate functions, design features, and operating characteristics/procedures of the LPH JP-5 fuel system and its components.

6-8. The primary reason an LPH has a JP-5 system is to provide fuel for
1. motor-driven generators
2. the ship's boilers
3. turbo-powered helicopters
4. the inert gas generator

6-9. Which pump(s) in the LPH 2 jet fuels system supply(ies) fuel to the fueling station on the flight deck?
1. Transfer pump only
2. Defueling pump
3. Service pump only
4. Transfer pump and service pump

6-10. Through the arrangement of valves and spectacle flanges, both the service pump and the transfer pump in the pumproom can do the job of the other. Under which of the following arrangements would the movement of fuel be slower than ordinary?
1. Transfer pump substituting for service pump when fueling
2. Service pump substituting for transfer pump when fueling only
3. Service pump substituting for transfer pump when defueling only
4. Service pump substituting for transfer pump when fueling and defueling

6-11. If one of the transfer pumps becomes inoperative while offloading JP-5, the remainder of the operation can be performed with the aid of the
1. gallery and hangar deck pumps
2. stowage pumps
3. service pumps
4. motor-driven stripping pumps

6-12. Which of the following statements best explains the need for a priming system on the JP-5 service pumps?
1. JP-5 must be pumped through the recirculating line into the service pump to lubricate the pump before starting
2. Air and fuel vapor must be removed from the distribution piping, manifolds, and tanks so that the JP-5 will flow freely when the service pump is started
3. JP-5 must be injected into the service pump mechanism in sufficient quantities during zero demand so that the pump will have positive head when it is started
4. Air and fuel vapor must be removed from the distribution piping, manifolds, and tanks, and they must be filled with JP-5 before pumping operations can begin

6-13. At what minimum discharge pressure will the service pumps shut off automatically?
1. 15 psi
2. 20 psi
3. 25 psi
4. 30 psi

6-14. Since the centrifugal purifier is rated at 200 gpm, both transfer pumps can be discharged into one purifier without harm.

6-15. Which statement concerning the helicopter fueling stations is INCORRECT?
1. Each aircraft fueling hose reel contains three 50-foot lengths of hose
2. An electrical circuit runs from the hose reel drum through a 1-inch gasket to the amplifiers
3. The motors used on gallery deck walkway stations are spraytight because of their exposed position
4. JP-5 that has been taken from the aircraft by the defueling pump is discharged overboard through the 2-inch overboard discharge line

Learning Objective: Identify operational procedures and sequences applicable to various JP-5 fuel systems, including safety precautions to be taken.

6-16. If an aircraft suspected of containing JP-4 must be defueled, the fuel should be directed into the ship's stowage system.

6-17. Immediately prior to the transfer of JP-5 to the service tanks, stowage tanks should be stripped. This statement refers to the JP-5 system on which of the following types of ships?
1. CVAs
2. CVs
3. LPHs
4. All of the above

6-18. Which of the following statements concerning the common procedures for filling the JP-5 stowage tanks on CVAs, CVs, and LPHs is correct?
1. Service tanks can be filled directly from the tanker provided the portable air-driven filters are used
2. Before filling commences, the manifold valves should be secured to avoid routing fuel into the service tanks, bypassing the purifier
3. The ship's main drain and eductor system should be utilized to deballast any tanks filled with sea water
4. The valves in the filling and transfer system should be lined up from the deck filling connection directly to the first stowage tank

6-19. Fueling aircraft with JP-5 is accomplished under the direction of the aviation JP-5 officer and includes all the following personnel EXCEPT the
1. plane captain
2. man who stands by to mop up any spilled JP-5
3. man who stands by with the CO_2 fire extinguisher
4. man who attaches the fueling hose nozzle to the aircraft

6-20. Under which of the following circumstances should the JP-5 fueling crew stop fueling immediately?
1. The fuel temperature at discharge reaches 80° F
2. The fuel pressure downstream of the regulator reaches 60 psi
3. The fuel pressure at discharge reaches 100 psi
4. The fuel pressure downstream of the filter reaches 100 psi

6-21. To properly complete his fuel record, what should the division officer ensure has been accomplished?
1. The tanks have been checked each month for water so that appropriate action can be taken
2. The fuel in the tank has been rotated every three months, and the tanks have been ballasted and deballasted
3. The tanks have been sounded each week to compare the liquid level gage reading with the sounding tape reading
4. The fueling crews have kept an accurate reading of fuel pumped to each plane

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Learning Objective: Indicate the characteristic of nitrogen and carbon dioxide that permits their use for preventing or extinguishing fire aboard ship, and recognize operating and maintenance principles and procedures, characteristics, and construction features of a shipboard nitrogen system and its components.

6-22. Which of the following gases may be used near electrical equipment?
1. Oxygen
2. Hydrogen
3. Nitrogen
4. Acetylene

6-23. The oxygen-nitrogen producers aboard aircraft carriers are operated and maintained by personnel of the
1. air department
2. fuels division
3. engineering department
4. V-4 division

6-24. N_2 used for the protection of the gasoline systems must have a minimum purity of
1. 100 percent
2. 97 percent
3. 47 percent
4. 43 percent

6-25. N_2 is normally stored at a pressure of
1. 300 psi
2. 500 psi
3. 3,000 psi
4. 5,000 psi

6-26. The pressure reducing panel controls the reduction of pressure of the N_2 gas for the cofferdams to
1. 15 psi
2. 10 psi
3. 7 psi
4. 4 psi

6-27. Release of N_2 into the cofferdams is controlled by the
1. relief valve
2. escape valve
3. shutoff valve
4. stop valve

6-28. The relief valves in the N_2 system allow excess gas to be delivered to the
1. storage flasks
2. reducing panel
3. atmosphere
4. compressor

6-29. To ensure against excessive pressure in the cofferdams, a bypass line containing a relief valve is installed around the shutoff valve.

6-30. The first step in charging the cofferdams with N_2 is to open the
1. supply valve
2. relief valve
3. air escape valve
4. shutoff valve

6-31. What percent of inertness of CO_2 and N_2, respectively, should show on the portable inertness analyzer before you close the valve in the air escape line?
1. CO_2 - 35, N_2 - 35
2. CO_2 - 35, N_2 - 50
3. CO_2 - 50, N_2 - 35
4. CO_2 - 50, N_2 - 50

6-32. When must the AvGas quadrants be drained back and purged?
1. Before each day's operations
2. After each day's operations
3. Before each refueling operation
4. After each refueling operation

6-33. The ABFs who operate and maintain the AvGas pumprooms and filter rooms will most likely be responsible for maintaining
1. and operating the O_2-N_2 producers
2. the N_2 distribution panel only
3. and operating the N_2 distribution system
4. the CO_2 system only

Learning Objective: Recognize operating principles and procedures pertinent to a shipboard carbon dioxide system, and indicate the location and function of selected components of the system.

6-34. The fixed CO_2 system installed in the AvGas pumproom is supplied from cylinders located in the
1. motor room
2. access trunk
3. filter room
4. O_2-N_2 producer room

6-35. How are the release valves for the fixed CO_2 system operated?
1. Electrically
2. Hydraulically
3. Pneumatically
4. Manually

6-36. The CO_2 system in the filter room has a timed delay when the pull box is activated to permit personnel to leave the space. How long is the delay?
1. 10 to 20 sec
2. 20 to 30 sec
3. 30 to 40 sec
4. 1 min

6-37. When the CO_2 gas is released, a smothering foam blanket is spread over a wide area by
1. vanes
2. spring-type nozzles
3. diffuser horns
4. bell-shape nozzles

6-38. As soon as the CO_2 system in the AvGas pumproom is activated, what do the pressure-operated switches do?
1. Actuate the visual alarm only
2. Actuate the audible alarm only
3. Turn off the ventilating fans in the pumproom and secure all pumping operations
4. Actuate the audible alarm and the electrical controller

6-39. Which condition will exist when the ventilating fans are operating and the green light is on?
1. The CO_2 has been used, and the audible alarm has been turned off while repairs are being made
2. Auxiliary power is being used to operate the ventilating fans
3. Ventilation in the spaces is normal
4. The audible alarm system is inoperative

6-40. The purpose of lube oil systems aboard aircraft carriers is to
1. provide an emergency supply of oil for support equipment
2. store and distribute jet engine oils only
3. store and distribute reciprocating engine oils only
4. store and distribute reciprocating engine and jet engine oils

6-41. What are the major components of the independent aviation lube oil systems?
1. Pumps, gages, and valves
2. Pumps, valves, and piping
3. Drums, piping, valves, and pumps
4. Tanks, thermometers, pumps, and hoses

6-42. When the lube oil stowage tanks are filled from drums, the flow of oil from each drum is controlled by the
1. top cap of the drum
2. large cap over the funnel
3. filling connection cap
4. filling pump pressure

6-43. When lube oil is off-loaded from a truck on the dock to a ship, why is a vent NOT necessary?
1. The manholes of the truck are open for the operation
2. The system is automatically vented through the tank to the overflow tank
3. The filling connection is open
4. The pump used to boost the lube oil from the dock to the ship is vented

6-44. What is the maximum number of gallons of lube oil that should be put into a 1,000-gallon stowage tank?
1. 1,000 gal
2. 990 gal
3. 950 gal
4. 850 gal

6-45. Before being discharged to service stations, lube oil in the stowage tanks should be preheated to an approximate temperature of
1. 84° F
2. 92° F
3. 100° F
4. 108° F

6-46. In what order should you take the following steps to provide lube oil from the stowage tank to the ready service tank?
A. Open the rotary plug valves on each side of the back pressure valve
B. Open valve G from the tank
C. Open valves E and F at the strainer inlet and outlet
D. Open valves A and B of the desired pump
E. Start the Pump
1. B, D, C, A, E
2. B, C, D, E, A
3. B, A, C, D, E
4. B, E, A, C, D

6-47. What gage is used to observe the filling conditions when oil is being pumped from the stowage tank to the ready service tank?
1. Pressure return gage
2. Main deck riser gage
3. Stowage tank level gage
4. Ready service tank level gage

6-48. Which valves should be left open when you secure the lube oil system?
1. M and N
2. M and Q
3. N and P
4. P and Q

6-49. Which of the following sources should be checked as a source of contamination each time lube oil is dispensed from them?
1. The stowage tanks
2. The ready service outlets
3. The ready service tanks
4. Internal piping and valves

Learning Objective: Relative to the DeLaval-IMO series 31P156 lube oil pump, recognize characteristics, component functions, operating and maintenance principles and procedures, construction features, causes of malfunctions, and responsibilities for maintenance of logs.

6-50. What type of pump is used in the aviation lube oil system?
1. Vertical, centrifugal, shaft-type, nonpositive displacement, dual stage
2. Vertical, rotary, screw-type, positive displacement, single stage
3. Vertical, impeller-driven, screw-type, positive displacement, single stage
4. Vertical, rotary, shaft-type, nonpositive displacement, dual stage

6-51. The idler rollers perform which of the following functions?
1. They drive the pump and provide power for the power rotor
2. They reduce oil flow at the discharge end and at the rotor head
3. They seal and aid in moving the oil
4. They lubricate the pump by permitting leakage at the discharge and suction passage

6-52. What drives the pump idler rotors?
1. The helical grooves of the pump shaft
2. The chain gear driving rotor
3. The drive shaft
4. The power rotor

6-53. Axial thrust acting on the power rotor is absorbed by the
1. thrust washers
2. idler rotors
3. rotor bearing block
4. balance piston

6-54. How are the rotor guides and locating elements in the pump lubricated?
1. By manual oiling
2. By the oil being pumped
3. By a special oil pump
4. By injection of grease through plug-type fittings

6-55. Adjusting screws in the upper end of the pump case serve to do which of the following?
1. Secure the rotor housing axially
2. Position the balance piston housing
3. Position the packing box end cover
4. All of the above

6-56. When a pump is started for the first time, how is the rust preventive compound effectively removed?
1. Through normal operation of the pump
2. By flushing with any approved solvent
3. By disassembly and brushing the internal parts with trichloroethylene
4. By operating the pump at low speed using JP-5 for flushing

6-57. What prevents oil from leaking at the point where the shaft passes through the packing box?
1. A flexible metallic packing ring and a packing gland
2. A packing gland and four staggered, flexible, metallic packing rings
3. Two aligned metallic packing rings and two flexible packing glands
4. Four staggered packing glands and a flexible packing ring

6-58. The packing glands are made in two parts so that the seal can remain intact even though part of the gland has to be removed in order to service the pump.

6-59. Air is removed from the pump suction line by filling the pump case and the suction line with oil. What is this process called?
1. Packing
2. Plugging
3. Priming
4. Discharging

6-60. What should you do if the pump does NOT discharge after several starts?
1. Test the discharge pressure
2. Test the suction pressure
3. Introduce air into the suction line
4. Run the pump several minutes without oil

6-61. A noticeable decrease in suction pressure near the pump indicates the possibility of
1. an obstructed suction line
2. worn bearing rings
3. improperly aligned helical grooves
4. loose gland nuts

6-62. What is the primary cause of rapid wear to the pump housing and bearings?
1. Failing to exercise proper maintenance procedures
2. Running the pump too fast
3. Running the pump without oil
4. Running the pump under excessive oil pressure

6-63. Which of the following conditions is indicated if there is a slight leakage around the shaft packing after the suction and discharge valves are opened and the motor is started?
1. Defective packing
2. Excessive discharge pressure
3. Inadequate suction pressure
4. Normal operation

6-64. How often should the suction and discharge pressure be checked when the pump is operating?
1. Constantly
2. Every 10 minutes
3. Hourly
4. Daily

6-65. To determine the amount of leakage around the case end covers, the pump should be
1. turned over by hand during inspection
2. running in normal operation during inspection
3. turned over by auxiliary power during inspection
4. disassembled for inspection

6-66. During operation of a lube oil pump, which of the following would NOT normally be the cause for leakage between the end covers and case, or in the piping connections?
1. Foreign matter on the gaskets
2. Loose nuts and bolts
3. Defective gaskets
4. Improper lubricant

6-67. A noticeable decrease in discharge pressure over a period of time indicates that
1. contaminated oil has been pumped
2. there is an obstruction in the discharge line
3. the bearing rings are worn
4. the helical grooves are not properly aligned

6-68. An excessive amount of air entrapped in the oil while the pump is operating may be indicated by
1. a low discharge pressure
2. a high discharge pressure
3. overloading
4. abnormal noises

6-69. Continued pumping of heavy or cold oil may cause
1. misalignment of parts
2. high discharge pressure
3. overloading
4. abnormal noises

6-70. Which of the following entries would NOT normally be made in the maintenance log?
1. Record of lubrications
2. Inspections
3. Part changes
4. Length of time pump was operated

6-71. Where should the smooth logs be retained?
1. In the aviation fuels division office
2. In the operations office
3. In the air office
4. In the engineering office

Assignment 7

Aviation Fuels Repair Team; Fuel Farms and Mobile Refuelers

Text: Pages 169 - 208

Learning Objective: Recognize the responsibilities and manning requirements of the aviation fuels repair team.

7-1. During general quarters, who is charged with the responsibility of coordinating all damage control matters?
1. Engineering officer
2. Damage control assistant
3. Aviation fuels officer
4. Air boss

7-2. Who is in charge of the aviation fuels repair team during general quarters?
1. An ABFC from the V-4 division
2. The aircraft crash and salvage officer
3. The maintenance officer
4. The aviation fuels officer

7-3. The majority of the members of the aviation fuels repair team are ABFs from which division?
1. V-1
2. V-3
3. V-4
4. V-6

7-4. The petty officer in charge of the aviation fuels repair team skeleton crew during flight quarters is generally an
1. ABF3
2. ABF2
3. ABF1
4. ABFC

Learning Objective: Indicate the duties, responsibilities, and manning requirements for the aviation fuels security watch.

7-5. When is the aviation fuels security watch stood?
1. Only when the ship is at general and flight quarters
2. At all times when the ship is underway
3. At all times when the ship is at general, fire, or flight quarters
4. At all times except when the ship is at general, fire, or flight quarters

7-6. Who normally stand the aviation fuels security watch?
1. ABF3s and ABF strikers
2. ABF2s and ABF3s
3. ABF1s and ABF2s
4. ABFCs and ABF1s

7-7. When is the aviation fuels security watch required to make entries in the pumproom and repair team logs?
1. At the beginning of his watch only
2. At the beginning and end of his watch
3. Hourly
4. At the end of his watch only

7-8. If the aviation fuels security watch discovers a leak in the aviation fuels system, whom must he notify immediately?
1. The OOD and the air department OOD
2. The air department duty officer, integrity watch officer, and the aviation fuels officer
3. The executive officer
4. The leading chief of the V-4 division

Learning Objective: Recognize uses, functions, operating characteristics and procedures, construction features, and safety precautions applicable to equipments used by the aviation fuels repair team.

7-9. What reading of the indicator dial on an explosimeter indicates a safe condition?
1. Zero to 0.2
2. 0.2 to 1.0
3. 1.0 to 2.0
4. Any reading above 2.0

7-10. What color on the dial band of an explosimeter indicates a dangerous condition?
1. Green
2. Red
3. White
4. Yellow

7-11. Refer to figure 9-1 in your textbook. What is the correct order in which you should take the following steps to use an explosimeter properly?
A. Throw the right-hand switch to ON
B. Throw the left-hand switch to READ
C. Turn the VOLT ADJ. knob to set the needle on the dial to the green arrow
D. Aspirate the bulb for fresh air and bring the needle to zero by turning the ZERO ADJ. knob
E. Throw the left-hand switch to CHECK
F. Test the space or compartment
1. A, B, C, D, E, F
2. A, C, B, E, D, F
3. A, D, E, B, C, F
4. A, E, C, B, D, F

7-12. For what purpose is a flame safety lamp used?
1. For emergency lighting
2. To determine the presence of explosive mixtures in the air
3. To determine the amount of oxygen in the air
4. To determine the amount of inert gas in a compartment

7-13. The font of a flame safety lamp should be filled with a high grade of
1. nonleaded gasoline or naphtha
2. leaded gasoline or naphtha
3. nonleaded gasoline or JP-5
4. leaded gasoline or JP-5

7-14. How many gauze cones are used in the construction of a flame safety lamp?
1. One
2. Two
3. Three
4. Four

7-15. Why must a flame safety lamp be lowered very slowly into and raised from the space under test?
1. To keep the fuel at a constant level
2. To prevent the flame from going out because of sudden movement
3. To prevent the flame from being drawn through the wire gauze
4. To prevent damage to the wire gauze

7-16. How is a deficiency of oxygen in a space being tested with a flame safety lamp indicated?
1. The flame flares up brightly
2. The flame flares up and then goes out
3. The flames goes out gradually
4. The flame goes out quickly

7-17. If the flame goes out with a slight "pop" when a compartment is tested with a flame safety lamp, what is indicated?
1. A concentration of explosive gas
2. A deficiency of oxygen
3. A lean concentration of explosive gas
4. An excessive amount of oxygen

Items 7-18 through 7-23 refer to the dual service portable inertness analyzer.

7-18. The principal function of the analyzer is to measure the
1. percentage of combustible hydrocarbons in samples of inert gas
2. amount of moisture and percentage of carbon dioxide in samples of inert gas
3. percentage of reduction in the oxygen content of inert gas samples
4. volume percent of nitrogen and carbon dioxide in samples of inert gas

7-19. Approximately how many minutes should the aspirating pump be operated for analyzing a mixture of air and inert gas in an enclosure?
1. Six
2. Five
3. Three
4. Four

7-20. Approximately how many minutes should the aspirating pump be operated for analyzing a mixture of air, inert gas, and hydrocarbon vapor in an enclosure?
1. Six
2. Five
3. Three
4. Four

7-21. How should the operator purge the analyzer?
1. By pumping fresh air through it in the same direction as the flow of gas
2. By washing it out with fresh water
3. By pumping fresh air through it in a direction opposite to the flow of gas
4. By allowing inert gas to flow through it freely

7-22. Immediately after completing an analysis, what should the operator do?
1. Turn rheostat C clockwise to set the indicator to 100 on the scale
2. Close the petcock on the gas-sample drier
3. Disconnect the vapor absorber inlet hose
4. Return the toggle switch to position A

7-23. Which of the following procedures may you use to reactivate the carbon in the red cylinder of the flame safety lamp if new carbon is NOT available?
1. Without using an open flame, heat the carbon in an open pan for one hour at 200° to 250° F
2. Suspend the carbon over an open flame for 30-45 minutes
3. Air dry the carbon in direct sunlight for a minimum of 24 hours
4. Force warm dry air over it for one hour or more

7-24. Hazardous fumes and vapors are removed from contaminated spaces by
1. the ship's ventilating system
2. suction fans
3. air-driven portable blowers
4. natural ventilation

7-25. How is excess air which enters the air line hose mask expelled?
1. Through the edges of the face mask
2. Through the control valve
3. Through the air hose
4. Through the low-pressure line

7-26. What causes the diaphragm of a sound-powered telephone transmitter to vibrate?
1. The armature
2. The permanent magnet
3. The pushbutton switch
4. The talker's voice

7-27. When repairs are made or other work is being done on or near aviation fuel handling equipment, tools made of all but which of the following materials may be used?
1. Wood
2. Plastic
3. Brass
4. Stainless steel

7-28. A complete listing of safety precautions for handling aviation gasoline is contained in the
1. Basic Military Requirements Training Manual
2. NAVSHIPS Technical Manual, Chapter 1550
3. NAVSHIPS Technical Manual, Chapter 9150
4. ABF 3 & 2 Rate Training Manual

Learning Objective: Recognize some characteristics of aviation fuels and associated hazards, and identify specific shipboard piping systems by color.

7-29. Mixtures of vaporized gasoline and air are explosive if their proportions are within certain limits. The lower limit of gasoline vapor in the air by volume which may result in a dangerous situation is
1. 0.6 percent
2. 1.4 percent
3. 4.1 percent
4. 6.0 percent

7-30. Which of the following is most likely to cause an explosion if ignited after it is opened?
1. A half tank of 115/145 AvGas
2. A half tank of JP-5
3. A full tank of JP-5
4. A full tank of 115/145 AvGas

7-31. If there is a gasoline leak in a compartment, how will the vapor be dispersed?
1. Greatest near the compartment overhead
2. Greatest at the level of the leak
3. Greatest near the compartment deck
4. The same throughout the compartment

Learning Objective: Indicate materials and procedures used in the repair of aviation fuels piping systems and supervisory responsibilities for the maintenance logbook.

7-32. How may a small hole in a pipe be repaired?
1. By wrapping a piece of canvas around the pipe and serving it with marlin
2. By drilling, threading, and inserting a screw
3. By inserting a small pine plug in the hole
4. By applying a plastic patch over the hole

7-33. What is the main disadvantage of a jubilee patch?
1. The kick-over time is too long
2. It requires special handling due to the toxic fumes given off when the adhesive compound is applied
3. Assorted sizes must be stocked since each patch is manufactured to fit only one size of pipe
4. It comes in only one large size and must be cut to fit smaller sizes of pipe

7-34. When the metallic pipe repair kit is used, most water and aviation fuel lines can be easily repaired and service restored to the system in as little time as
1. 30 min
2. 45 min
3. 60 min
4. 90 min

7-35. When the resins and hardeners are mixed together, at what temperature does the kick-over occur?
1. 95 to 110° F
2. 110 to 115° F
3. 120 to 135° F
4. 135 to 350° F

7-36. When a plastic patch is installed, how long after the kick-over does curing take place?
1. 10 min
2. 15 min
3. 30 min
4. 45 min

7-37. When a plastic patch is applied, how much of the patch should extend beyond the rupture on each side?
1. 2 to 3 in.
2. 2 1/2 in.
3. 3 in.
4. 4 to 5 in.

In items 7-38 through 7-41, concerning the plastic patch, select from column B the procedure that is associated with each statement in column A.

A. Statements

7-38. Check for explosive conditions before burning or using spark producing tools

7-39. Avoid spilling plastic materials

7-40. Mix thoroughly the activator and the resin

7-41. Secure the void cover on the pipe with spiraling chalk line

B. Procedures

1. Preparation
2. Application
3. Safety

7-42. In heat-producing areas where aviation fuel lines pass, the use of sheet metal shields is restricted to systems operating with less than how many pounds pressure?
1. 600 psig
2. 1,200 psig
3. 1,500 psig
4. 2,400 psig

7-43. Which of the following procedures is used to determine gasket compression?
1. The prescribed torque measurement on the bolts is adhered to strictly
2. A thickness measurement is taken in the 1/4 inch space allowed by the gasket's outside diameter
3. A thickness measurement is taken at each of the four notches cut at 90-degree intervals in the outside diameter of the gasket
4. A thickness measurement is taken at each of the six notches cut at 90-degree intervals in the inside diameter of the gasket

7-44. The maintenance logbook containing a record of all work performed on the aviation fuels systems is inspected frequently by the
1. appropriate petty officers
2. ship's engineering officer
3. planned maintenance system coordinator
4. air department maintenance officer

Learning Objective: Recognize fuel farm administrative and operating procedures, color codes of petroleum pipelines, and characteristics of fuel stowage tanks.

7-45. Fuel records for fuel farm operations are kept by what department?
1. Operations
2. Maintenance
3. Supply
4. Public works

7-46. To which fuel farm operation will military personnel most likely be assigned?,
1. Aircraft fueling
2. Pumping station maintenance
3. Inventory control
4. Transfer system repair

Refer to figure 10-1 in your textbook in answering items 7-47 through 7-49. Select from column B the number of color bands used to identify each petroleum pipeline listed in column A.

A. Pipelines		B. Color Bands
7-47.	JP-4 jet fuel	1. One
7-48.	100/130 AvGas	2. Two
7-49.	D-50 marine diesel fuel	3. Three
		4. Four

7-50. Where would you most probably find a stowage tank of the floating roof type?
1. Northern Alaska
2. Antarctica
3. Guam
4. Arctic area

7-51. The temperature of the earth affects the formation of fuel vapor in which of the following stowage tanks?
1. Floating roof
2. Expansion roof
3. Subsurface
4. Above surface

Learning Objective: Recognize fuel farm operating procedures.

7-52. Preparations for fueling aircraft include all but which one of the following?
1. Determining the readiness of the ready service tank
2. Pressurizing the fueling system and checking it for leaks and checking the associated equipment for discrepancies
3. Bringing the aircraft to the fueling point and installing pins or downlocks in the landing gear
4. Checking the aircraft for hot brakes prior to bringing it to the fueling point

7-53. What is the order in which the electrical grounds and the hose connections must be made before an aircraft is fueled?
1. Aircraft and refueler, nozzle and grounding cable, nozzle and aircraft, electrical power and aircraft
2. Aircraft and deck, refueler and aircraft, nozzle and aircraft, refueler and aircraft
3. Aircraft and refueler, nozzle and grounding cable, refueler and deck, nozzle and auxiliary power
4. Aircraft and deck, refueler and deck, aircraft and refueler, refueler and nozzle, nozzle and auxiliary power, nozzle and aircraft

7-54. What is the correct action to take if fuel is spilled onto the ground near one of two aircraft in a double-line refueling station?
1. Secure the fueling operations on the aircraft near the place the fuel was spilled and commence a washdown
2. Secure all fueling operations, commence a washdown, resume operations on the other aircraft
3. Secure fueling operations on the aircraft near the place the fuel was spilled and reposition it in the other lane after the other aircraft is fueled
4. Secure all fueling operations and commence a washdown

Learning Objective: Identify characteristics, functions, operating principles and procedures, and personnel responsibilities pertinent to the RF-50 mobile aircraft refueler and its components.

7-55. Which of the following statements relating to the refueler is correct?
1. It contains its own pump, filter/separator, meter, fuel quantity monitor, discharge nozzles, and control system
2. Its 5,000-gallon capacity tank is divided into two horizontal compartments
3. It can be operated by two men, one who controls the fuel flow and mans the hoses and the other who functions as a firewatch
4. Its fueling operations can be started and stopped only by manual operation of the balanced emergency valve

7-56. What is the specific job of the third man assigned to the crew of a refueler?
1. He is responsible for the operation of the refueler
2. He makes the actual fueling hookup to the aircraft
3. He is responsible for the grounding procedures
4. He serves as fire watch only

7-57. Which combination of pressures demanded by the various parts of the refueler to maintain a flow of 200 gpm is correct?
1. 1,650-psi pump pressure, 200-psi filter/separator pressure, and 45- to 80-psi nozzle pressure
2. 45-psi nozzle pressure and 105-psi filter/separator outlet pressure
3. 200-psi pump pressure and 105-psi filter/separator pressure
4. 1,650-psi pump pressure, 45-psi nozzle pressure, 200-psi filter/separator outlet pressure, and 80-psi constant pressure valve pressure

7-58. What components of the pumping equipment and accessories of the refueler are used to empty the hose of fuel?
1. The throttle valves
2. The automatic control valves
3. The pressure switches
4. The eductors

7-59. What purpose is served by the bottom-loading feature of the refueler?
1. It provides for control over fuel selection
2. It provides for greater fuel stability
3. It provides for reduced static electricity generation
4. All of the above

7-60. What is the defuel rate of the model 2246 mobile refueler?
1. 200 gpm
2. 100 gpm
3. 75 gpm
4. 50 gpm

7-61. The model 2246 mobile refueler's power takeoff is equipped with a separate gasoline engine.

7-62. What type of pump is used with the power takeoff unit of the model 2246 refueler?
1. Piston
2. Centrifugal
3. Rotary vane
4. Gear

7-63. Service hose reels are provided with a braking system to prevent the hoses from overrunning when the hoses are being rewound.

7-64. Where is the fuel quality monitor located on the 2246 refueler?
1. Upstream from the filter separator
2. On the control panel for the power takeoff
3. Downstream from the filter/separator
4. On the pump panel control switchboard

7-65. Which of the following valves is NOT part of the bottom loading control panel?
1. Tank vent control
2. Loading valve control
3. Pretest valve control
4. Hose valve control

7-66. The bottom-loading system of the refueler is powered from the
1. truck's hydraulic system
2. truck's airbrake system
3. accumulator
4. eductor system

7-67. The refueler driver is responsible for all but which of the following procedures associated with safe and proper fueling operations?
1. Grounding the refueler
2. Operating the refueler
3. Positioning the refueler
4. Connecting the fueling nozzle to the filling point

7-68. Although the refueler has provisions incorporated in it to prevent filling an aircraft with the wrong fuel, fuel restrictions are so critical to aircraft performance that the fuel served to each aircraft must be checked by both the refueler driver and the
1. flight line chief
2. plane captain
3. assistant driver
4. firewatch

7-69. What procedure must be followed to remove the small amount of fuel which remains in an aircraft's fueling system following normal defueling by the refueler?
1. The fuel must be withdrawn into disposable metal cans having covers
2. The fuel must be withdrawn into metal containers and buried as soon as possible
3. The fuel must be withdrawn into standard safety cans or placed in them as soon as possible
4. Any of the above procedures is acceptable, depending upon the circumstances

7-70. Assume that when preparations are being made to fuel an aircraft with 115/145 AvGas, the refueler's power takeoff malfunctions. The corrective maintenance should be performed by the
1. refueler crew
2. public works department
3. motor transport department
4. maintenance department of the unit having custody of the aircraft

7-71. The refuelers are allowed to cross runways but only when directed to do so by the
1. pilot of the aircraft to be fueled
2. tower
3. driver of the refueler
4. assistant driver of the refueler

7-72. Which of the following is the optimum placement of the refueler for fueling an aircraft?
1. On the windward side of the aircraft in a position 10 feet from the aircraft
2. On the downwind side of the aircraft in a position 10 feet from the aircraft
3. On the downwind side of the aircraft in a position which utilizes as much distance from the aircraft as the length of the hose permits
4. On the windward side of the aircraft in a position which utilizes as much distance from the aircraft as the length of the hose permits

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Learning Objective: Recognize component functions and operating procedures applicable to the MA-1A-1 aviation lube oil truck.

7-73. What is the function of the oil recirculating system of the truck?
1. To drain oil from the aircraft
2. To preheat the oil
3. To filter the oil
4. To build up oil pressure

7-74. A power takeoff control and a handbrake interlock device are provided on the truck to prevent engagement of the power takeoff until the handbrake is engaged.

Assignment 8

Fuel Farms and Mobile Refuelers; Fueling, Defueling, and Purging Aircraft Fuel Systems; Environmental Pollution Control

Text: Pages 208 - 238

Learning Objective: Recognize operating characteristics of the valves of lube oil service trucks.

8-1. If the pump of the truck operates with excessive noise and vibration, the most probable cause is that the
1. handbrake is not engaged
2. gate valve is open
3. emergency valve is closed
4. oil temperature is too low

Refer to figure 10-9 in your textbook in answering items 8-2 and 8-3.

8-2. For which operation of the truck must valve 2 be closed?
1. Draining the tank
2. Preheating the oil
3. Pumping out the tank
4. Pumping from an outside source

8-3. Which valves must be kept closed during the preheating operation?
1. 1 and 3
2. 1, 2, and 4
3. 2 and 3 only
4. 2, 3, and 4

Learning Objective: Identify characteristics of miscellaneous fuel stowage and dispensing systems.

In items 8-4 through 8-8, select from column B the fuel stowage and dispensing system with which each statement in column A is most closely identified.

	A. Statements		B. Systems
8-4.	It was designed to fuel large aircraft	1.	High-speed Air Transportable Fuel Dispensing System
8-5.	It was originally designed for Marine Corps advance base airfields	2.	Helicopter Expedient Refueling System
8-6.	It can be used to fuel small aircraft and ground vehicles with limited flow-rate requirements	3.	Tactical Airfield Fuel Dispensing System
8-7.	It has 6 pillow tanks having a 20,000-gallon capacity each	4.	It dispenses fuel at a maximum rate of 600 gallons per minute
8-8.	It dispenses fuel at a maximum rate of 600 gallons per minute		

Learning Objective: Recognize elements of the fueling/defueling organization aboard carriers, and indicate types, construction features, and operating characteristics and procedures of specific shipboard fueling/defueling equipments, including safety and handling precautions.

8-9. All fueling and defueling of aircraft aboard carriers and all operations of the aviation fuels system are under the direction of the
1. assistant operations officer
2. assistant air officer
3. aviation fuels officer
4. aviation fuels chief

8-10. What constitutes a fueling crew aboard a carrier?

1. An ABF crew leader and a phone talker
2. ABFs to man the CO_2 bottles
3. ABFs to handle the fueling hoses and ABFs to stand by to remove spilled fuel
4. All of the above

8-11. The crew leader of a carrier fuel crew reports directly to the

1. aviation fuels officer
2. aviation fuels chief
3. division leading petty officer
4. flight deck or hangar deck fuels petty officer, as applicable

Items 8-12 through 8-15 refer to the Parker pressure fueling nozzle.

8-12. A single point, leakproof connection is formed between the nozzle and the aircraft's fuel system by a/an

1. adapter contained in the nozzle
2. adjustable coupling that is attached to the nozzle
3. adapter installed on the aircraft
4. flexible plastic hose assembly that is bolted to the aircraft

8-13. After you have coupled the nozzle and the adapter to form a fluid-tight connection, you open the passage into the aircraft fuel manifold by

1. lifting the bayonet lock
2. raising the lifting handle
3. rotating the valve opening handle
4. rotating the poppet valve

8-14. Toggle action opens the poppet valve completely and locks it when the flow control handle is rotated how many degrees?

1. Less than 45°
2. Between 45° and 90°
3. Between 90° and 180°
4. More than 180°

8-15. What should you do immediately after you remove the nozzle from the aircraft adapter?

1. Pull the safety cap over the face of the nozzle
2. Disconnect the nozzle from the fuel line and replace the dust cover
3. Pull the dust cover over the face of the nozzle and replace the safety cap on the aircraft adapter
4. Disconnect the adapter from the aircraft and return it to the plane captain

8-16. Which of the following correctly lists the necessary events in the order of their occurrence to permit fuel to flow into an aircraft via the inflight refueling probe?

1. The adapter is connected to the probe, opening the probe nozzle valve → the adapter is locked by spring-loaded balls → a fuel-tight seal is made by the O-ring → the fueling nozzle opens allowing fuel to flow
2. The adapter is connected to the probe nozzle → the adapter is locked by a spring-locked bayonet lock → the O-ring makes a fuel-tight seal → the fueling nozzle opens and fuel flows into the probe
3. The adapter is connected to the probe nozzle, opening the probe nozzle valve → the adapter is locked by a spring-loaded bayonet lock → the O-ring makes a fuel-tight seal → the fuel nozzle opens allowing fuel to flow
4. The adapter is connected to the probe nozzle → the adapter is locked by spring-loaded balls → the O-ring makes a fuel-tight seal → the fuel nozzle opens allowing fuel to flow causing the probe nozzle to open

8-17. What type of hose is used for defueling and fueling aircraft from the AvGas stations aboard a carrier?

1. 1 1/2-inch hard hose only
2. 2 1/2-inch hard hose
3. 2 1/2-inch collapsible hose only
4. 1 1/2-inch hard hose or 2 1/2-inch collapsible hose

8-18. Determine if each statement relative to the hose used in fueling and defueling aircraft is true or false, then select the alternative that lists the true statements.

A.___The fittings are normally made of brass

B.___The fittings will NOT mesh properly with pipe fittings

C.___The hose, whether hard or collapsible, is made of fuel-resistant rubber

1. A and B only
2. A, B, and C
3. A and C only
4. B and C only

8-19. Before the last small amounts of fuel are drawn from a defueled aircraft into a safety can, what should be done?

1. The ground wire on the aircraft should be connected to the can
2. The ground wire on the can should be connected to the deck
3. The ground wire from the fuel hose nozzle should be connected to the can
4. The ground wire on both the can and the aircraft should be connected as in 1 and 2 above

8-20. The portable defueling pump is operated by a motor that is driven by
1. sea water pressure
2. low-pressure air
3. electricity
4. hydraulic pressure

8-21. In defueling a jet aircraft having single point fueling/defueling capability, you connect the suction hose to the aircraft by means of
1. a pressure fueling nozzle
2. the aircraft pressure fueling adapter
3. inserting the suction hose into the tank fill opening
4. pushing the suction hose up over a drain fitting on the bottom of the tank

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Learning Objective: Recognize the personnel, procedures, and precautions associated with fueling, defueling, and purging aircraft with specified equipment under specified conditions.

8-22. The first step prior to beginning fueling operations on a carrier equipped with an automatic fuel/defuel valve type station is to
1. reel out and ground the fueling hose nozzle to the aircraft
2. place the nozzle switch in the OFF position and ground the switch to the aircraft
3. check the station supply riser fuel pressure
4. complete the below deck aviation fuels systems operation instructions

8-23. In fueling an aircraft on a carrier equipped with Wayne or Blackmer fueling stations, deenergizing the solenoid valve for the 4-way valve causes the fuel to
1. cease flowing because the pump stops
2. stop flowing from the hose but continue to flow through the pump
3. evacuate from the hose into the piping
4. flow from the hose into the aircraft

8-24. What is the purpose for operating the fuel/defuel valve type of station in the fueling position immediately prior to commencing defueling operations?
1. To prime the pump
2. To prime the hose line
3. To check solenoid activation
4. To check the 4-way valve control

8-25. An ABF3 who desires a list of the procedures to follow and the precautions to take in fueling a particular type of aircraft should consult the
1. applicable aircraft technical manual
2. Air Department Organizational Manual
3. Operation Manual for Aviation Fuel Systems
4. NAVSHIPS Manual

8-26. Safety precautions for fueling an aircraft require that the aircraft be protected from the hazards associated with which of the following?
1. Static electricity in the refueler
2. Static electricity in the aircraft
3. The power output from radio or radar (RF energy)
4. All of the above

8-27. Who normally mans the cockpit of an aircraft while it is being fueled?
1. An ABFAN or an ABF3 assigned to monitor the fuel quantity gage
2. The ABF in charge of the fueling crew
3. The plane captain
4. The driver of the external power cart

8-28. Refer to figure 11-8 in answering 8-28. During aircraft fueling, the man in the cockpit signals the fueling station operator by moving his right hand, with fingers outstretched, from side to side. The operator knows that he is being directed to
1. ADD FUEL
2. STOP FUEL
3. CHECK PRIMARY
4. CHECK SECONDARY

In items 8-29 through 8-32, select from column B the member of an aircraft fueling crew who performs each duty listed in column A.

	A. Duties		B. Members
8-29.	Connects and operates the pressure fueling nozzle	1.	The man in the cockpit
8-30.	Sets the switches on the fuel management panel	2.	The man at the fueling station control panel
8-31.	Starts the flow of fuel into the aircraft and stops the flow when signaled to do so	3.	The man at the aircraft fueling panel
8-32.	Keeps constant watch on the fuel quantity gages		

8-33. The operator at which fueling position must be informed if NO airflow is felt at a particular vent?

1. Cockpit
2. Maintenance control
3. Fueling station control panel
4. Aircraft fueling panel

8-34. There is a constant danger of fire and of personnel being injured because of the difficulty of communications with each other when aircraft engines are running. Therefore, procedures different from those used for normal fueling are used when prechecking, vent monitoring, grounding, and switch sequencing an aircraft for hot refueling.

8-35. Who among the following men is stationed in the aircraft cockpit during hot refueling?

1. The pilot
2. The plane captain
3. The fueling crew chief
4. The fuselage ram air monitor

8-36. Before being directed into the fuel pit for hot refueling, the pilot must secure all of the aircraft's electrical and electronic equipment.

In items 8-37 through 8-40, select from column B a function performed by each of the personnel listed in column A who are involved in hot refueling an aircraft.

	A. Personnel	B. Functions
8-37.	Plane captain	1. Starts the flow of fuel into the aircraft
8-38.	Pilot	
8-39.	Nozzle operator	2. Maintains UHF radio contact with the tower
8-40.	Aircraft fueling panel operator	3. Attaches the ground wire to the aircraft
		4. Checks the aircraft for hot brakes

8-41. Which of the following must be grounded before an aircraft is defueled?

1. The aircraft only
2. The fueling nozzle only
3. The defueling unit and fueling nozzle only
4. The aircraft, fueling nozzle, and defueling unit

8-42. Which of the following conditions would prevent the outboard wing tanks of an A-6A aircraft from being defueled automatically during an emergency?

1. The wings are folded only
2. The drop tanks are empty only
3. The fuselage tanks are empty
4. The drop tanks are empty, and the wings are folded

8-43. Which of the following indicates the correct sequence in which the fuel tanks of an A-6A aircraft are defueled?

1. Wing tanks → centerline stores drop tank → wing drop tanks
2. Fuselage tank → wing tanks → wing drop tanks
3. Drop tanks → wing tanks → fuselage tanks
4. Fuselage tank → wing tanks → centerline stores drop tank → wing drop tanks

8-44. Assume that during defueling operations the plane captain notes that the wing fuel gage reads 0 and he signals STOP DEFUEL and switches the wing gate valve to CLOSE but the fuel continues to flow. How is this fuel flow explained?

1. The wing fuel gage is incorrect
2. The wing gate valve is malfunctioning
3. The fuselage tank begins draining as soon as the wing tanks are empty
4. The wing gate valve switch is ineffective

8-45. Because aviation fuel fires are class B fires, the fog foam system and CO_2 units should be manned while defueling is in progress.

8-46. Fueling and defueling an aircraft must be done only by

1. aircraft crews
2. aircraft maintenance crews
3. aviation fuels crews
4. crews under the direction of ABFCs

8-47. In what order should you take the following steps to ground an aircraft properly during refueling?

A. Remove the cap from the filler connection
B. Connect the ground wire from the aircraft to the metal deck
C. Attach the insert nozzle to the filler connection
D. Connect the ground wire from the nozzle to the aircraft

1. B, A, D, C
2. B, C, D, A
3. B, D, A, C
4. B, D, C, A

Learning Objective: Define air pollutants and methods of controlling air pollution.

8-48. Which of the following problems was of primary concern under the original pollution control laws?

1. Eliminating water pollution
2. Regulating the amount of coal to be burned
3. Reducing smoke from fossil fuels
4. Controlling the types of fuel used

8-49. Which of the following statements is correct concerning smog pollution?

1. It is caused by the burning of fossil fuels
2. It is a mixture of smoke mixed with other gases
3. It is another name for smoke pollution
4. It is caused by sunlight acting on certain gases

8-50. Which of the following statements is INCORRECT concerning carbon monoxide?

1. It can be minimized by adding more air during combustion
2. It is a colorless, odorless, nonpoisonous gas
3. It is caused by the burning of fuels
4. It is one of the most common pollutants

8-51. What is the minimum amount of carbon monoxide per million parts of air considered damaging to personnel after exposure for approximately eight hours?

1. 6 parts
2. 8 parts
3. 10 parts
4. 12 parts

8-52. What contribute(s) the largest percent of contamination by particulate matter?

1. Forest fires
2. Stationary fuel combustion
3. Industrial processes
4. Automobile exhaust fumes

8-53. What is the minimum range of particulate matter contamination (in micrograms per cubic meter) found to affect the overall death rate?

1. 20 to 40
2. 40 to 60
3. 60 to 80
4. 80 to 100

8-54. Which of the following techniques would NOT be useful in reducing particulate contamination from a boiler stack?

1. Centrifugal separation
2. Retrofitting
3. Electrostatic precipitation
4. Washing

8-55. Sulfur oxide is produced by burning fuel containing sulfur. Which type of fuel contributes the largest percent of this contaminant?

1. Wood
2. Oil
3. Gas
4. Coal

8-56. Which source is responsible for over one-half of the estimated 32 million tons of hydrocarbons produced each year?

1. Industry
2. Wood burning
3. The gasoline engine
4. The use of coal

8-57. Which factor is necessary to form photochemical oxidants from nitrogen oxides and gaseous hydrocarbons?

1. A low temperature
2. Sunlight
3. An open flame
4. Carbon monoxide

8-58. Which type of pollution is caused by a mixture of photochemical oxidants with solid and liquid particles?

1. Smog
2. Fog
3. Particulate matter
4. Chemical

8-59. Which of the following types of national pollution problems were of primary concern when the clean air act of 1963 was enacted?
1. Particulate matter pollution
2. Vehicle pollution only
3. Sulfur dioxide pollution only
4. Vehicle and sulfur dioxide pollution

8-60. In what year was the clean air act first amended?
1. 1964
2. 1965
3. 1966
4. 1967

8-61. In addition to eliminating pollution from gasoline engines, the use of positive crankcase ventilation (PCV) systems will prevent which of the following conditions?
1. A buildup of sludge
2. Excessive condensation
3. Excessive combustion
4. Ring shifting

8-62. Which of the following items would NOT be considered a direct problem in reducing motor vehicle pollution?
1. Engine size
2. Fuel
3. Fuel additives
4. Control devices

8-63. Which item is of primary concern in relation to pollution by motor vehicles?
1. Nitrogen oxides
2. Hydrocarbons
3. Tetraethyllead
4. Particulate matter

Learning Objective: Recognize water pollution by organic waste and oil and define preventive and corrective measures to be taken.

8-64. Which of the following water pollution problems is caused by excessive organic waste?
1. Loss of emulsions
2. Loss of oxygen
3. Excessive oxygen
4. The forming of sludge

8-65. What is the most serious problem concerning water pollution?
1. Excessive heat
2. Eutrophication
3. Accelerated biological changes
4. Accelerated chemical changes

8-66. In what year was the water quality improvement act passed?
1. 1964
2. 1967
3. 1970
4. 1973

8-67. The Navy policy on oil spills is to remove the oil from the water by
1. physical means
2. use of chemical emulsifiers
3. use of sinking agents
4. burning

8-68. Who has the primary responsibility for mobilizing personnel and material in order to contain a major oil spill?
1. Coast Guard
2. Navy
3. Environmental protection agency
4. Industrial oil removal corp

8-69. Oil spills are classified as minor, medium, or major. Which of the following statements is correct concerning the classification of oil spills?
1. The amount spilled, plus posing a threat to public health and welfare, determines the classification
2. The classification depends on the threat to public health only
3. The only criterion for classification is the amount spilled
4. The amount of public concern that is generated determines the classification

8-70. Which office is directly responsible for the development of training to assist others in combating spills?
1. Area coordinators
2. Fleet Commanders-in-Chief
3. Chief of Naval Material
4. CNO

8-71. Which of the following statements is INCORRECT concerning the organization of the National Oil and Hazardous Substances Pollution Contingency Plan?
1. The area coordinators are responsible for implementing the development of a contingency plan
2. The Navy response center is responsible for supporting the area coordinators
3. The Navy on-scene coordinator is a single Navy officer
4. The area coordinator designates the Navy representatives to the regional response team

8-72. Which response mode would be used to indicate that a spill may be beyond existing capabilities?

1. Routine
2. Standby
3. Alert
4. Serious

8-73. What is the minimum number of miles a ship must be at sea in order to clear the prohibited zone and dump trash and rubbish?

1. 25 mi
2. 50 mi
3. 75 mi
4. 100 mi

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